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FINAL REPORT

LITTLE SNAKE RIVER BASIN
SMALL RESERVOIR DEVELOPMENT PROJECT
LEVEL II

SUBMITTED TO:

WYOMING WATER DEVELOPMENT COMMISSION

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October 30, 1998
LITTLE SNAKE RIVER BASIN
SMALL RESERVOIR DEVELOPMENT PROJECT
LEVEL II

FINAL REPORT

Submitted To:
Wyoming Water Development Commission
Herschler Building, 4th Floor
122 West 25th Street
Cheyenne, WY 82002

Submitted By:
Lidstone & Anderson, Inc.
760 Whalers Way, Suite B200
Fort Collins, CO 80525
(LA Project No. WYWDC11)

October 30, 1998
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I. INTRODUCTION

1.1 Authorization and Purpose

In the fall of 1996 the Wyoming Water Development Commission (WWDC) received an application for Level III funding from the Little Snake River Conservation District (District). The District originally requested $687,000 (60% grant, 40% loan) to fund the construction of 34 small impoundments in the Little Snake River Basin. As proposed by the District, the ponds are to be constructed on several tributaries to the Little Snake River and Separation Creek watersheds and are intended primarily for livestock watering, rangeland improvement and wildlife habitat enhancement. The District estimated the project would improve 25 ranching operations and 22,400 acres of rangeland. Figure 1 presents a general location map of the Little Snake River and Separation Creek in the vicinity of Baggs and Rawlins, Wyoming.

The WWDC recommended that the application be modified to reflect the completion of a Level II project to determine the feasibility of constructing 34 small impoundments within the boundaries of the District. The proposed modification was subsequently approved by the WWDC for funding.

On May 30, 1997 Lidstone & Anderson, Inc. (LA) entered into a contract with the WWDC to provide professional services related to the Little Snake River Basin Small Reservoir Development Level II Project. As stated in the contract, the purpose of the Level II project is to complete the conceptual designs and cost estimates for 34 potential reservoir sites ranging in capacity from approximately 5 acre-feet to over 100 acre-feet. The primary purpose of the impoundments is to provide for livestock watering and consequently, improvements to rangeland. Secondary benefits include the potential increase in wildlife habitat, wetland development, and fisheries. The reservoirs are located on lands owned by federal, state and private entities.

The scope of services for this project consists of: (a) review of proposed reservoir sites; (b) completion of technical analyses associated with hydrology, water rights, geotechnical issues, sedimentation and water quality; (c) determination of reservoir service area; (d) evaluation of wetland banking potential; (e) preparation of conceptual designs and cost estimates; (f) identification of necessary permits and environmental studies; and (g) development of a financing plan and completion of a benefit-cost analysis. This report summarizes the results of this Level II study.

In addition to the work summarized in this final report, the WWDC requested that a companion document be prepared to present information pertinent to the evaluation, conceptual design and funding of future livestock reservoir projects. A report entitled “Little Snake River Basin
Figure 1. Location Map
1.2 History of the Project

Numerous stock ponds and reservoirs have been historically constructed within the boundaries of the District. Recent aerial photography documents the existence of both active and inactive or breached stock ponds. The Bureau of Land Management (BLM) has been responsible for the design and construction of many stock ponds on federal lands located within the District. In addition, the District with the support of the Natural Resources Conservation Service (NRCS) has been responsible for the recent design and construction of several additional stock ponds and reservoirs. Individual landowners have also completed projects with NRCS assistance. In some locations, the design and construction of the livestock reservoirs has specifically incorporated benefits to wetlands and wildlife. An example of a pond which was constructed by the District in recent years is illustrated in Figure 2.

Figure 2. Existing Stock Pond in the Little Snake River Basin
In general, these existing ponds have varied in storage capacity from less than 2 acre-feet to over 100 acre-feet. The majority of the ponds incorporated embankments that were less than 20 feet in height; consequently, many of the ponds were considered nonjurisdictional by the State Engineer's Office and were eligible for a special permitting process as stock ponds/reservoirs. Where ponds were located on property owned by the BLM, the BLM has provided the surveying requirements along with equipment to facilitate construction. The local office of the NRCS has largely been responsible for providing the design drawings and specifications for the construction of the ponds and reservoirs. Typically, the design procedures have been obtained from documents promulgated by the NRCS (e.g., Pond 378).

Information obtained from Larry Hicks, manager for the District and Norm Vigil, project engineer for the local NRCS office indicates that ponds recently constructed by the District have been operating reasonably well. Mr. Hicks indicated that an analysis of spillway hydraulics may be warranted for the design of future ponds. Increasing the size of the principal spillway (pipe spillway) will reduce the frequency of flows on the emergency spillway thereby reducing potential erosion. This is especially pertinent for those reservoirs which capture limited storage within a small contributing drainage basin. In addition to erosion of the emergency spillway, Mr. Vigil reported that some of the existing ponds have experienced sedimentation problems which tend to limit the original capacity and potential useful life of the structures.

The District has interacted with several of the state and federal agencies responsible for permitting the construction of these ponds/reservoirs. Specifically, these agencies have included the State Engineer's Office, Corps of Engineers (Section 404 Permit), State Historic Preservation Office, Department of Environmental Quality/Water Quality Division, U.S. Fish & Wildlife Service, Bureau of Land Management, and Wyoming Game and Fish Department. The vast majority of these agencies are informed of the construction of the reservoirs through the Section 404 Permit process. Historically, the existing ponds/reservoirs were permitted under an agricultural exemption or a nationwide permit.

Presently, the District assesses all property owners through a mill levy. The mill levy generates approximately $110,000 per year which is utilized to cover the operation and maintenance costs associated with the District. Limited funds are available for allocation to the construction of the ponds/reservoirs. To date, Mr. Hicks has been very successful in obtaining monies for the construction from a variety of funding sources. The funding sources have included Ducks Unlimited; Wyoming Game and Fish Department (trust fund grants); EPA 319 monies; state farm bill program; Water for Wildlife; and the Pronghorn Foundation. Money from these sources combined with the construction and surveying support provided by the NRCS and the BLM have resulted in the cost effective construction of the existing ponds/reservoirs. This construction has occurred without an increase in the mill levy associated with the District.
II. PROJECT SCOPE MEETING

2.1 Data Collection

After LA received the notice to proceed with the project, all available information was collected and reviewed. This information included available mapping, data and reports pertinent to the evaluation of the stock ponds and reservoirs. Limited topographic mapping was available within the basin; consequently, the USGS quad maps (scale of 1" = 2,000') were utilized to complete the work effort associated with the project. Digital quad maps were obtained to facilitate the presentation of results and provide flexibility for future changes to either the location or preliminary design of each reservoir. Aerial photography was also obtained from the Wyoming Water Development Office. This photography was utilized to verify the location and status of existing reservoirs within the basin.

In preparation for writing the proposal and conducting the interview for this project, the project team conducted a preliminary review of available data and reports and interviewed several sources of information. Prior to the scoping meeting, a more detailed review of this information was completed. In addition to the review and evaluation of available mapping and photography, the data collection efforts primarily consisted of the following items.

1. Reviewing several reports pertinent to the work anticipated for the project. These reports include the following:


2. Discussing potential water rights constraints with John Barnes of the State Engineer’s Office. Constraints associated with dam safety issues were discussed with Dave Benner. This work also included a review of pertinent information related to the Little Snake River in the Upper Colorado River Basin Compact.

3. Discussing Section 404 potential permitting requirements with Chandler Peter of the Corps of Engineers in Cheyenne, Wyoming.

4. Discussing wetland issues and the wetland banking program with Bill DiRienzo of the Department of Water Quality.

5. Discussing design procedures and construction specifications associated with the proposed reservoirs with Norm Vigil of the NRCS. Larry Hicks of the District provided information related to the existing reservoirs constructed within the Little Snake River Basin.

2.2 Project Scoping Meeting

A project scoping meeting was conducted on June 16, 1997 in Baggs, Wyoming. The purpose of the meeting was to discuss specific locations for the potential stock ponds/reservoirs as well as project goals, scope of work and project schedule. The attendees at the meeting included the following:

- Mike Carnevale          Wyoming Water Development Commission
- Shawn Steiner          Inberg-Miller Engineers
- Paul McCarthy          PMPC Engineers
- Gary Steele            PMPC Engineers
- Brad Anderson          Lidstone & Anderson, Inc.
- Larry Hicks            Little Snake River Conservation District, Manager
- Jack Cobb              Little Snake River Conservation District Board
- Denise Vandas          Little Snake River Conservation District Board
- Jim Chant              Little Snake River Conservation District Board
- Norm Vigil             Natural Resources Conservation Service
During the scoping meeting, the discussions focused on the identification and evaluation of the stock ponds/reservoirs. The following items were specifically discussed during the meeting.

- To the maximum extent possible, the reservoirs should be conceptually designed to store as much water as possible yet be less than 20 feet in height to simplify potential permitting and submittal requirements associated with the State Engineer’s Office (submittal of a simplified stock pond/reservoir form).

- The number of beneficiaries associated with each stock pond should be determined. The WWDC prefers to maximize the number of beneficiaries.

- Access and ownership will be evaluated during the project. The WWDC considers access important with respect to potential public benefits associated with each pond. Ownership will range from federal lands to state lands to private land owners.

- Permitting requirements must be identified. Coordination with the U.S. Army Corps of Engineers (COE) should be conducted to determine the permitting associated with Section 404 of the Clean Water Act. The District prefers to submit each stock pond/reservoir as an individual project. The project should identify all sites eligible for an agricultural exemption and also those sites which could be permitted under a nationwide permit.

- Criteria for the design and construction of the stock ponds/reservoirs should be formulated. Presently, NRCS design procedures as documented in Pond 378 are followed.

- An investigation of potential wetland credits associated with wetlands created by this project should be completed. The investigation should include eligibility for deposit into the Statewide Wetland Bank, potential use of wetland credits for mitigation, limitations of wetland credits, and potential transfer of wetland credits to the State of Wyoming.

At the end of the meeting, a discussion of the potential location for the 34 stock ponds/reservoirs was held with Larry Hicks. Mr. Hicks agreed to assist the project team in coordinating access to each site for the inventory work.
III. REVIEW OF PROPOSED RESERVOIR SITES

3.1 Field Inventory

Immediately following the scoping meeting, a field reconnaissance of several existing and proposed stock ponds/reservoirs was conducted. Larry Hicks conducted the field reconnaissance and was accompanied by three members of the project team. Initial coordination with Mr. Hicks identified 35 sites for the field inventory. The location of the 35 reservoir sites is presented on Figure 3. Table 1 presents the reservoir identification, location and water source for each of the 35 sites.

To ensure access to all of the proposed reservoir sites, the field inventory was scheduled for the last two weeks in July 1997 and continued through August 1997. Mr. Hicks provided assistance in the coordination required for access to each site. An inventory form was developed to ensure the field work was conducted consistently from site to site and to logically display all pertinent data associated with each reservoir site. The inventory form provides a summary of pertinent information related to:

- source of water;
- contributing drainage area;
- reservoir service area;
- location of public access roads/accessibility;
- type of ownership (federal, state or private);
- identification of potential beneficiaries/landowners;
- soil suitability with respect to reservoir construction;
- topographic considerations which may limit potential reservoir size with respect to dam height and storage capacity;
- identification of existing wetlands;
- potential to enhance wetland values; and
- potential to enhance wildlife and fisheries.
Figure 3. Location of Proposed Reservoirs
Table 1. Location and Water Source of Proposed Reservoirs

<table>
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3.3
During the evaluation of each reservoir site, the inventory form was expanded to include more detailed information related to reservoir location, access, type of stream (ephemeral, intermittent, perennial, etc.), description of terrain and range conditions, and identification of existing reservoirs. Photographic and video documentation of each site was also collected to facilitate the evaluation and conceptual design along with the determination of existing wetlands. The inventory forms prepared for each of the 35 reservoir sites are provided in Appendix A. Ownership and land status mapping in the vicinity of each site is presented in Appendix B. Table 2 summarizes the land ownership and potential project beneficiaries associated with each of the 35 reservoir sites.

3.2 Evaluation of Existing Reservoirs

As indicated previously, the field work conducted immediately following the scoping meeting included a reconnaissance of five existing stock ponds/reservoirs. Four of the reservoirs were located in the Little Snake River Basin while one existing reservoir was located within the Separation Creek Basin. The field reconnaissance of the existing reservoirs was intended to: (a) identify the nature and extent of existing design and/or construction related problems, and (b) utilize this information in the formulation of design and construction criteria for the proposed reservoirs.

It is our understanding that the existing reservoir sites were designed and constructed according to guidelines and procedures promulgated by the NRCS or the BLM. In general, these guidelines recommend a 3H:1V slope on the upstream embankment and a 2H:1V slope on the downstream embankment. Based on observations taken during the field reconnaissance, two of the existing reservoirs that were not constructed in accordance with the guidelines experienced the most significant erosion problems. Typically, the upstream embankment slope was much steeper than 3H:1V and erosion of the embankment was occurring due to wave action. Furthermore, the emergency spillways were observed to be eroding especially at the location where the spillway reenters the stream channel. It is likely that lack of vegetation along both the embankment and spillway contributed to the erosion. At one reservoir reportedly constructed in the Fall of 1996, both the upstream and downstream embankment appeared to be constructed at a slope of 1H:1V. In addition, seepage was evident along the abutment with noticeable erosion of the embankment materials. The surficial embankment materials contained a significant amount of woody debris and silty soils. Figure 4 illustrates the erosion along the embankment of the existing reservoir.

Following the field reconnaissance, Inberg-Miller Engineers prepared a memorandum documenting the condition of the existing reservoirs which were observed during the field reconnaissance. The complete memorandum is presented in Appendix C.
Table 2. Land Ownership and Project Beneficiaries for Proposed Reservoirs.

<table>
<thead>
<tr>
<th>Reservoir Identifier</th>
<th>Land Ownership Status</th>
<th>Project Beneficiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baggs 27</td>
<td>Federal</td>
<td>Roger J. Pilgrim</td>
</tr>
<tr>
<td>Blue Gap 16</td>
<td>Federal</td>
<td>Montgomery Livestock, Snake River Land Company</td>
</tr>
<tr>
<td>Blue Gap 27</td>
<td>Federal</td>
<td>Weber Ranch, Inc.</td>
</tr>
<tr>
<td>Bridger Pass 6</td>
<td>Federal</td>
<td>P.H. Livestock</td>
</tr>
<tr>
<td>Bridger Pass 12</td>
<td>Federal</td>
<td>P.H. Livestock</td>
</tr>
<tr>
<td>Bridger Pass 32</td>
<td>Federal</td>
<td>P.H. Livestock</td>
</tr>
<tr>
<td>Browns Hill 10</td>
<td>Private</td>
<td>Cobb Cattle Company, John T. Cobb</td>
</tr>
<tr>
<td>Browns Hill 21</td>
<td>Federal</td>
<td>Sam Morgan</td>
</tr>
<tr>
<td>Browns Hill 27</td>
<td>Federal</td>
<td>Stratton Sheep, Snake River Land Company</td>
</tr>
<tr>
<td>Cottonwood Rim 10</td>
<td>Private</td>
<td>Frank &amp; Carroll Marie Marsh</td>
</tr>
<tr>
<td>Cottonwood Rim 17</td>
<td>Private</td>
<td>Medicine Bow, Inc.</td>
</tr>
<tr>
<td>Dixon 11</td>
<td>Federal</td>
<td>Matt Weber</td>
</tr>
<tr>
<td>Dixon 15</td>
<td>Private</td>
<td>Matt Weber</td>
</tr>
<tr>
<td>Dixon 34</td>
<td>Private</td>
<td>Ladder</td>
</tr>
<tr>
<td>Doty Mountain 5</td>
<td>Federal</td>
<td>Weber Ranch, Inc.</td>
</tr>
<tr>
<td>Garden Gulch 3</td>
<td>Private</td>
<td>Montgomery Livestock, Matt Weber</td>
</tr>
<tr>
<td>Garden Gulch 32</td>
<td>Federal</td>
<td>Snake River Land Company</td>
</tr>
<tr>
<td>Ketchum Buttes 1</td>
<td>Federal</td>
<td>Montgomery Livestock, Matt Weber</td>
</tr>
<tr>
<td>Ketchum Buttes 3</td>
<td>Federal</td>
<td>Bruce Their, Wanger Ranches</td>
</tr>
<tr>
<td>Ketchum Buttes 25</td>
<td>Federal</td>
<td>Montgomery Livestock, Desert Cattle Company, Stratton Sheep Company</td>
</tr>
<tr>
<td>Ketchum Buttes 34</td>
<td>Private</td>
<td>Sandstone Ranches</td>
</tr>
<tr>
<td>McCarty Ranch 8</td>
<td>State</td>
<td>Don Stratton</td>
</tr>
<tr>
<td>Peach Orchard Flat 6</td>
<td>Federal</td>
<td>James L. Chant, Jr.</td>
</tr>
<tr>
<td>Peach Orchard Flat 34</td>
<td>Federal</td>
<td>Montgomery Livestock, Snake River Land Company</td>
</tr>
<tr>
<td>Pine Grove Ranch 1</td>
<td>State</td>
<td>Don Stratton</td>
</tr>
<tr>
<td>Pole Gulch 22</td>
<td>Federal</td>
<td>Stratton Sheep</td>
</tr>
<tr>
<td>Pole Gulch 27</td>
<td>Private</td>
<td>Stratton Sheep</td>
</tr>
<tr>
<td>Riner 28</td>
<td>Federal</td>
<td>Wyoming Game &amp; Fish, James L. Chant, Jr.</td>
</tr>
<tr>
<td>Savery 4</td>
<td>Private</td>
<td>Kaisler Brothers</td>
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<td>Savery 8</td>
<td>Private</td>
<td>Donald McCalister</td>
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<tr>
<td>Savery 18</td>
<td>Private</td>
<td>Cobb Cattle Company</td>
</tr>
<tr>
<td>Smiley Draw 3</td>
<td>Federal</td>
<td>Snake River Land Company</td>
</tr>
<tr>
<td>Smiley Draw 27</td>
<td>Federal</td>
<td>Montgomery Livestock, Snake River Land Company</td>
</tr>
<tr>
<td>Tullis 6</td>
<td>Private</td>
<td>John T. Cobb</td>
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<tr>
<td>Tullis 30</td>
<td>Private</td>
<td>Peter Lee &amp; Donna Jones, Reba Y. Sheehan, Sheehan Ranches</td>
</tr>
</tbody>
</table>

3.5
3.3 Design and Construction Guidelines

As part of this project, the existing design and construction guidelines pertaining to stock ponds and reservoirs were reviewed and evaluated. These guidelines include those listed below.


Based on the review of the existing guidelines, preliminary recommendations related to the design and construction of the proposed stock ponds and reservoirs were prepared. Appendix D presents the preliminary guidelines.
To provide an estimate of the historic yield associated with each reservoir location, a hydrologic analysis of the contributing watershed is required. Several methods were evaluated to conduct this analysis. The most accurate procedures involve the evaluation of gaging data from nearby gaging stations. However, continuous streamflow data within the Little Snake River Basin and Separation Creek Basin is either unavailable or limited and where this data is available, extrapolation of the data to smaller drainage basins would result in inaccurate estimates. Alternatively, regression equations have been developed that provide insight into the annual yields from small drainage basins. To provide estimates of the annual water yields, regression equations from the following documents were evaluated:


The evaluation of the regression equations resulted in the selection of the procedures documented by Lowham (1988). Estimates of the annual water yield at each of the proposed reservoir sites is presented in Table 3. Documentation of the annual water yield is presented in Appendix E.

Estimates of the annual water yield provide valuable data which are necessary to determine the potential water available for livestock and other purposes at each reservoir site. The reservoir yield will be reduced by sediment accumulation, evaporation, seepage and water rights associated with senior appropriators. Due to the limited irrigation within the basins, senior water rights which reduce the potential reservoir yield are largely related to existing and active stock ponds and reservoirs. During this project, the location of all active stock ponds was determined through an investigation of the records in the State Engineer’s Office and a review of aerial photography. All active stock ponds and stock ponds/reservoirs identified as part of this project are presented on Figure 5. During the evaluation of each reservoir, the annual water yield into the reservoir was reduced by the water associated with each senior appropriator.
Table 3. Annual Water Yield, Peak Flood Flows and Sediment Yield at Proposed Reservoirs.

<table>
<thead>
<tr>
<th>Reservoir Identifier</th>
<th>Annual Water Yield (AF)</th>
<th>Peak Flow (cfs)</th>
<th>Annual Sediment Yield (AF)</th>
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<td></td>
<td></td>
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<td>25-yr 50-yr 100-yr</td>
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<td>60 152 242</td>
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<td>447 603 791</td>
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<td>558 762 1,011</td>
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<td>24</td>
<td>25 69 114</td>
<td>198 275 370</td>
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<td>227 314 422</td>
</tr>
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<tr>
<td>Tullis 30</td>
<td>588</td>
<td>14 24 32</td>
<td>45 55 67</td>
</tr>
</tbody>
</table>
Figure 5. Location of Active Stock Ponds and Proposed Reservoirs
V. FLOOD ANALYSES

In conjunction with completion of the hydrologic analysis, estimates of the peak flood flows at each potential reservoir location were determined. The peak flow data are necessary to design the dam embankments as well as the principal and emergency spillways.

Two methods for the determination of peak flows for ungaged basins in Wyoming have wide acceptance and were considered applicable to the Little Snake River Basin and Separation Creek Basin. These methods are documented in Craig and Rankl (1978) and Lowham (1988). Both methods were investigated for their applicability to generate reasonable peak flow data. The results of the investigation indicated that both methods provide similar estimates for peak flood flows. However, since the method described by Lowham (1988) was selected for estimating the annual water yield, the procedures documented in Lowham (1988) were also selected to estimate peak flood flows at each reservoir site.

The results of the flood analyses are also presented in Table 3. Appendix E provides the documentation for the flood analyses.
VI. GEOTECHNICAL EVALUATION AND BASIN GEOMORPHOLOGY

6.1 General

During the completion of this project, all available geological information was collected. This information coupled with pertinent soil survey data, provided an indication of the suitability of the sites for construction of the dam embankments. The field work provided the basis for the generation of site-specific geologic and surficial soils mapping. Each reservoir site was evaluated with respect to considerations for soil and geologic suitability including soil permeability, bearing capacity and ease of excavation associated with both soils and bedrock. The potential to utilize soils in the vicinity of each reservoir site as borrow sources was also identified. The suitability of the on-site materials for the foundation of the embankment as well as the embankment materials was qualitatively determined. The results of this work effort were also utilized to determine the cost estimates for construction of the reservoir embankments.

6.2 Field Exploration

Each of the proposed reservoir sites were visited to evaluate site-specific geologic and surficial soil conditions. At each proposed site, hand auger samples were collected near the existing stream channel and near one of the abutment locations. Sampling depths typically extended 4 to 5 feet below the ground surface to give an indication of the soil conditions at the site. Surficial soil conditions were observed and all rock outcroppings or significant soil or geologic conditions were noted. The soil samples were field classified by a geotechnical engineer, sealed in containers to prevent loss of moisture and transported to the offices of Inberg-Miller Engineers. All samples were reinspected by the geotechnical engineer and reclassified visually in accordance with ASTM D2487.

6.3 Surficial Soil Mapping

Surficial soil mapping was obtained from either the Rawlins District Office of the BLM or the NRCS Saratoga Office. No soils mapping was available for the Cottonwood Rim 10 or Cottonwood Rim 17 Reservoirs. Soil interpretations which are based on the soils maps are intended for general planning purposes only. Additionally, surficial soils mapping is limited to a description of soils to a maximum depth of 5 feet.
Summaries of the surficial soils in the vicinity of each reservoir site were prepared. The summaries divide the soil mapping units into primary and secondary soils. The primary soils are those located in the immediate vicinity of the proposed embankment and represent the soils which have the greatest potential for use as a borrow material. Secondary soils lie outside the high water line of the proposed reservoir and are not considered as likely a source of borrow materials due to the haul distances and the requirements for reclaiming the borrow area after construction. Soils mapping illustrating the primary and secondary soil types were prepared as part of this work effort.

Each soil map unit is comprised of one to three different soils types or series. The soil series are listed by name and include some engineering properties that provide an indication of the suitability of the soil for use in embankment construction. The properties listed for each soil series include the USDA texture, classification of the soils based on the Unified Soil Classification System (USCS) and the American Association of State Highway and Transportation Organizations (AASHTO) classification system, the range of liquid limits and plasticity indices, the range of permeability and the range of particle sizes. In addition, each of the soil map units are rated for limitations related to embankment construction. Factors considered in rating the embankment are depth of soil material, seepage, piping, compaction difficulty, large stone content, wetness, excess sodium and excess salts. Shallow soils usually limit the feasibility of a site for a reservoir due to a lack of material for embankment construction. The more sandy soils have higher permeabilities which can cause seepage. Piping is caused by soils that disperse easily such as silty soils and soils high in soluble salts. Soils containing hard, dry, clayey materials are difficult to compact due to the excessive pore space. Large stone content limits the use of equipment for compaction and increases the difficulty associated with compaction. Wetness limits material available for construction of embankments. Excess sodium and salt creates problems with vegetation establishment which may ultimately lead to erosion of the embankment. Excess sodium also affects piping as salts dissolve and form small channels for water to move through the embankment. Summaries which describe the surficial soils and present soils mapping in the vicinity of each reservoir site are provided in Appendix F.

6.4 Geologic Mapping

The geologic formation of each of the proposed reservoir sites was determined using the digital geologic map available at the University of Wyoming-Spatial Data and Visualization Center. The digital map allows the user to visually determine the geologic formation given the location of the reservoir. This information was verified by the Wyoming State Geologic Map prepared by Davis and Love (1985) and the Carbon County Geologic Map prepared by Weitz and Love (1952).
The information obtained from the geologic mapping provides an indication of the foundation materials at each site. Typically, the geologic formations in the vicinity of the proposed reservoirs consist of sandstone or shale. The geologic mapping does not provide, however, information related to the depth or degree of weathering associated with the bedrock formation. Prior to construction of the reservoirs, a subsurface exploration program should be conducted to verify the foundation conditions. Information related to the geologic formations in the vicinity of the proposed reservoirs is also provided in Appendix F.

6.5 Basin Geomorphology

As part of this project, a qualitative geomorphic assessment of each drainage basin and stream channel was conducted. Information to perform this assessment was obtained from the field inventory as well as a review of aerial photography. To the maximum extent possible, this work included identification of the historic plan form changes in the vicinity of each reservoir as well as areas of potential channel bed and bank stability. In general, the embankments associated with each reservoir were located to minimize potential problems associated with the geomorphic evolution of the stream channel. Where channel bed and bank stability problems continue to persist, placement of channel stabilization measures will be required prior to construction of the reservoirs.
VII. SEDIMENTATION AND WATER QUALITY

Especially pertinent to any reservoir project is the potential loss of capacity due to sedimentation. Equally important is the long-term water quality of the water impounded by the dam embankment. The water quality must be adequate to meet the intended uses associated with the reservoir; for this project these uses may include livestock and wildlife watering as well as aquatic and fisheries enhancement.

At the request of the WWDC, the project team evaluated each potential reservoir site with respect to the loss of storage attributable to sedimentation. The quantity of sediment eroded from the upstream watershed is influenced by several factors including bedrock geology, soil type, vegetation, precipitation and temperature, topography and land use. With respect to precipitation, it should be noted that the greatest sediment yields within the Yampa River Basin are associated with drainages receiving an average of 12 inches of rainfall per year. A decrease in sediment yield occurs for a watershed which receives greater than 12 inches of mean annual precipitation; this is primarily a result of increased vegetative cover. For those drainages receiving less than 12 inches of rainfall per year, the sediment yield is limited by the available runoff. Within the boundaries of the Little Snake River Conservation District, the rainfall varies from approximately 9 to as high as 16 inches per year; consequently, mean annual precipitation will have an important impact on the sedimentation of potential reservoir locations. Information obtained from U.S. Geological Survey Water Resources Investigations 78-105 indicates that the most significant sediment source for the Yampa River (approximately 60 percent of the sediment load) is the lower portion of the Little Snake River Basin. This includes the drainage area within the Little Snake River Conservation District which is located downstream of Dixon, Wyoming. This publication also provides insight to the sediment yields within the Little Snake River Basin. In general, the results reported in the publication indicated values ranging from 100 to 500 tons/square mile/year. Information in this publication along with data related to regional erosion rates were evaluated to determine the annual loss of reservoir capacity due to sedimentation. These estimates were extrapolated to determine the potential loss of capacity after 20 years of operation.

The initial results of the annual sediment accumulation predicted by the USGS publication indicated a significant loss of reservoir capacity in the majority of the proposed reservoirs. Based on this information along with comments received from Mr. Hicks, the annual sediment accumulation at several reservoir sites was evaluated using the Modified Universal Soil Loss Equation. The results of this evaluation indicated a reduction in the initial results predicted by the USGS publication for all reservoirs with a contributing drainage area which exceeded 6 square miles. The reduction ranged from 60 to 70 percent of the initial sediment accumulation volumes.
Consequently, for those reservoirs with a contributing drainage area exceeding 6 square miles, the annual sediment accumulation predicted by the USGS publication was reduced by an average of 65 percent. The annual sediment yield predicted for each reservoir site is presented in Table 3.

In conjunction with the evaluation of reservoir sedimentation, a preliminary assessment of the water quality expected in each potential reservoir was conducted. Due to the nature of this project, water quality was related to its effect on the development of water for livestock and wildlife consumption. Total dissolved solids (TDS) is the major chemical parameter that could adversely impact long-term water quality. Baseline water quality along with historic yield and evaporation from the surface of the ponds could increase the TDS concentrations within the reservoirs. Upper limits for stock water are approximately 10,000 mg/l. Range cattle can become accustomed to drinking water of concentrations at 10,000 mg/l, but sodium and chloride must be the major constituents for this level to be acceptable; high sulfate concentrations are not acceptable. In addition to TDS, selenium has been reported in high concentrations within the Little Snake River Basin. Specific information related to the impact of selenium on the proposed Sandstone Reservoir indicated that construction of the reservoir was not expected to increase the concentrations of selenium in the reservoir water greater than maximum contaminant levels for public drinking water supplies and freshwater aquatic organisms. This information, along with data available from nearby gaging stations and other pertinent reports, was utilized to assess the potential water quality within the reservoir pools.

Based on a review of existing data along with the information discussed above, it is anticipated that the water stored within the reservoirs will be acceptable for consumption by both livestock and wildlife. Insufficient information was collected to determine the impact of water quality on aquatic and fisheries enhancement. It is important to note, however, that several existing stock ponds appear to have sufficient water yield and adequate water quality to enhance aquatic habitat. Furthermore, assuming the pools offer sufficient depth to sustain a fishery, the water quality does not appear to adversely impact establishment of a fishery at the proposed reservoir sites.
VIII. RESERVOIR SERVICE AREA

The area of rangeland that would be improved or served by each potential reservoir was specifically identified. Estimates of this area were obtained during the initial data collection efforts and refined following the inventory of potential reservoir sites. These estimates were based on anticipated travel distances associated with both livestock and wildlife. Other factors utilized to determine the reservoir service area included topographic relief and proximity as well as dependability of other water sources.

Following the determination of the reservoir service area at each site, the potential increase in the livestock (AUMs) on the rangeland was estimated. The BLM estimates the capacity of the rangeland in this region to vary from 4 to 10 acres per AUM. Assuming 4 acres per AUM at each reservoir location, the total number of AUMs which benefit by the reservoir was determined. The results of this analysis are presented in Table 4. Appendix B presents the delineation of the reservoir service area for each site.
Table 4. Reservoir Service Area and AUM Data.

<table>
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<th>AUMs Supported by Reservoir</th>
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8.2
IX. WETLAND BANKING EVALUATION

9.1 Discussion of Existing Wetlands

Although the project team originally intended to delineate the jurisdictional wetlands at the proposed reservoirs as part of this project, it was determined that detailed delineations were not necessary to complete this Level II project. In conjunction with the final design and permitting associated with Level III construction of any reservoir, identification of the jurisdictional wetlands should be completed.

During the field inventory, the project team collected data to document the existence of potential wetlands at each site. Photographic and video documentation of the existing vegetation, drainage channel and soils were provided to the Ms. Karyn Classi to assess the likelihood that wetlands or waters of the U.S. would be impacted by site development. This assessment was utilized to determine the likely permitting requirements/options as well as the level of effort and probable costs of permitting associated with each reservoir. Information collected during the field inventory was also utilized to identify those sites where habitat improvement or wetland development may be reasonable and prudent goals.

9.2 Potential for Wildlife, Wetlands and Fisheries Enhancement

One of the goals of this project is to design other resource values such as wildlife habitat, wetlands, and fisheries, into selected reservoirs where there is good potential to develop these attributes. Whereas the primary function of the project is to develop additional sources for livestock watering, enhancement of these other values is highly desirable. Created wetlands may also be eligible for inclusion in Wyoming's Wetland Bank.

The purpose of this analysis is to provide the WWDC with a list of reservoirs, ranked according to their potential to develop wildlife habitat/wetlands or fisheries, and to evaluate the possibility that any wetlands that are created would be eligible for wetland banking.

For the purposes of this evaluation, it was assumed that stockponds with wildlife habitat/wetlands are more desirable resources than those with fisheries values because fisheries development would require additional expenditures to stock and possibly restock reservoirs to initiate and maintain the fishery. On the other hand, stockpond development is likely to attract wildlife without additional expenditures; waterfowl, big game, etc. are likely to use the ponds for watering as soon as the additional water is available, and associated riparian vegetation is likely to be used for shelter and foraging by a variety of wildlife (especially birds). Wetland banking was
determined to be a less desirable goal than wildlife habitat/wetlands, because it is likely that ponds will eventually fill with silt and lose their wetland value. Without maintenance, wetland development would be temporary, and resources would have to be expended to evaluate the suitability of each wetland for inclusion in the wetland bank, as well as to maintain wetland values and functions.

The potential for wildlife habitat/wetlands development was based on the following information.

Reservoir depth. Shallower reservoirs would favor the establishment of wetland vegetation around the reservoirs' margin which in turn would promote use by wildlife.

Presence of existing wetlands or wetland vegetation. Reservoirs with existing wetlands or wetland vegetation were deemed to have greater potential for enhancement or maintenance of these attributes compared to reservoir sites surrounded by upland vegetation.

Channel and reservoir geometry. Wetland development would most likely be successful where impoundments create areas that are periodically inundated or saturated such that anaerobic conditions persist long enough to allow the establishment of hydrophytic vegetation. Steeply incised channels and steeply banked reservoirs were considered unfavorable because there would be reduced opportunities for establishment of wetland vegetation and access by wildlife.

Water source. Spring-fed reservoirs and larger watersheds were deemed to have greater potential for wildlife habitat/wetlands development because there would be a more dependable source of water.

Reservoir life span. Longer-lived reservoirs were considered more favorable because there would be more opportunity to establish wetland vegetation and for the reservoir to become a reliable water source for wildlife.

The potential for development of fisheries was based on the following criteria.

Water source. Spring fed reservoirs and larger watersheds were deemed to have greater potential for fisheries development because there would be a more dependable source of water.

Reservoir depth. Reservoirs with depths of 10 feet or more were ranked most favorable because there would be less potential for winter kill of the fish population.
Reservoir size. Larger reservoirs were considered more favorable because they could support a larger, and thus possibly self-sustaining, fish population.

Reservoir life span. Longer-lived reservoirs were considered more favorable because they would constitute a more reliable water source and offer a greater opportunity for establishment of a self-sustaining fishery.

The quantity (acres) of wetlands likely to develop at each reservoir was the primary criterion used to evaluate wetland banking potential. The extent of wetlands was estimated by determining the amount of backwater created by the dam as a function of the surrounding terrain. Wetland development would be most likely where impoundments create areas that are periodically inundated or saturated. Reservoir life span, and thus the potential to maintain these wetlands, was also considered.

From the perspective of qualitative gains with a minimum of additional effort, it was assumed that development of wildlife habitat/wetlands is a more desirable outcome than fisheries or wetland banking; consequently, the wildlife habitat/wetlands attribute was given a weight of "2" during the evaluation process. Fisheries and wetland banking attributes were given a weight of "1". The evaluation process also ranked each of the three attributes from 1 to 3. A rank of 1 was "least favorable", 2 was "moderately favorable", and 3 was "most favorable", relative to other reservoirs. To identify those reservoirs that provide the most potential for enhancement of other resource values, weight was multiplied by rank for each attribute, and the weighted scores were summed to determine the most favorable reservoir sites. The results of the evaluation process are presented in Table 5.

The reservoir sites considered the most favorable for development of all three attributes (wildlife habitat/wetlands, fisheries and wetland banking) were Blue Gap 16, Blue Gap 27, Ketchum Buttes 25, Peach Orchard Flat 34, Pine Grove Ranch 1, Garden Gulch 32, Riner 28, Smiley Draw 27, and Cottonwood Rim 10. Fishery potential was maximized at all sites where reservoir depth, reservoir volume and water source may be sufficient to support a fishery, specifically Garden Gulch 32 and Smiley Draw 27. For wetland banking, seven of the reservoir sites were considered to have the most potential for establishment of wetlands.

9.3 Wyoming Wetlands Bank

As indicated in the previous paragraphs, each site was evaluated to determine its potential to create, restore, or enhance wetlands for inclusion in the Wyoming Wetland Bank. Since construction of the stock ponds/reservoirs may create wetlands that may be eligible for the State Wetlands Bank, the WWDC may have an interest in obtaining ownership for these wetland banking
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credits. The credits may be beneficial in terms of mitigation associated with future water development projects. Ownership of the wetland banking credits belongs to the landowner; consequently, a legal agreement will be required to transfer the ownership of these credits to the District and ultimately the WWDC.

The limitations associated with the wetland banking credits reduce their potential value. Geographically, the wetland credits must be utilized within the region in which the credits were derived. Conversations with Matt Bilodeau from the COE Wyoming Regulatory Office in Cheyenne, Wyoming indicate that utilization of these credits could be further restricted to the watershed in which the credits were derived. This means that credits generated within the Little Snake River Basin may be limited to mitigation for projects within the Little Snake River Basin. With respect to the ecologic limitation, credits can only be utilized as mitigation if they are associated with a project within the same biotic region.

To date, no wetland banking credits have been withdrawn as mitigation for a construction project within the State of Wyoming. The use of wetland banking credits as mitigation for future projects has not been tested; consequently, the viability of this process is unknown until a project has been identified and successfully passed the scrutiny of the COE/EPA permitting review process.

Finally, it may not be prudent to invest significant resources to facilitate wetland development at each stock pond/reservoir site. The potential for success is relatively low at some sites due to environmental factors such as low precipitation, high evaporation, possibly high sedimentation rates, sandy soils and seepage, topography, and the life expectancy of the impoundment(s). These factors tend to inhibit the formation of self-sustaining wetlands suitable for banking.

Appendix G presents a summary of the State Wetland Banking Program.
X. CONCEPTUAL DESIGNS AND COST ESTIMATES

10.1 General

A letter was submitted to the District on December 30, 1997 which enclosed specific information related to the conceptual design of ten (10) of the 35 proposed reservoir sites. The letter specifically pertained to those stock ponds/reservoirs considered potentially eligible for an agricultural exemption with respect to compliance with Section 404 of the Clean Water Act. Following a review of the letter, a coordination meeting with the District and the WWDC was conducted on February 2, 1998. At this meeting, the District and WWDC provided comments related to the permitting, evaluation and conceptual design of the proposed reservoirs. Mr. Hicks provided specific comments on several proposed reservoirs in a memorandum to LA dated February 26, 1998. The comments included removal of four proposed reservoirs from further consideration; these sites included Browns Hill 10, Dixon 15, Savery 8 and Cottonwood Rim 17. Additional comments pertained to modifications to six sites. These sites included Riner 28, Bridger Pass 32, Blue Gap 27, Blue Gap 16, Peach Orchard Flat 34 and Tullis 30.

During the coordination meeting in February, the criteria identified for evaluating each reservoir site were reviewed and discussed. Comments provided by the District and WWDC were integrated into the procedures developed for evaluation of proposed reservoirs.

The remainder of this chapter describes the results of the evaluation process as well as the preparation of conceptual design information and cost estimates.

10.2 Evaluation of the Proposed Reservoirs

An integral part of the planning process associated with this Level II project is the development of evaluation criteria. The criteria identified for evaluation of the proposed stock ponds/reservoir sites are intended to guide the WWDC in the evaluation, conceptual design and funding of future livestock reservoir projects. In addition, these criteria, along with an evaluation matrix, were developed to assist in the selection and priority ranking of the stock pond/reservoir projects associated with this Level II project.

The list of criteria for evaluating the stock ponds/reservoir sites was developed in conjunction with input received from key members of the project team including Mike Carnevale (WWDC staff) and Larry Hicks (District). The primary and secondary criteria which were developed are identified below.

10.1
10.2.1 **Primary Evaluation Criteria**

The capability of each site to provide for a *Reliable Water Source* is considered very important. A site that provides a reliable water source is determined to be one that would provide a 20-year supply of water for livestock purposes. The reservoir yield was compared to the stock water requirements based on the AUMs supported by the service area. A value of 4 acres per AUM is utilized to determine the livestock supported by the reservoir service area. Typically, the reservoir yield considers the capacity of the reservoir, sediment accumulation and evaporation. Where the annual water yield associated with the watershed upstream of the dam site greatly exceeds the storage capacity of the reservoir, evaporation and seepage were neglected. Stock water requirements assumed consumption of 18 gallons per day per animal unit and a duration of 5 months. The results of this comparative analysis are displayed in Table 6. The most favorable sites provide for a 20-year supply for livestock purposes.

*Livestock Benefits* are evaluated by comparing the cost to lease rangeland with and without construction of the proposed reservoir. It is assumed that the rancher(s) will not increase the size of the herd which will be supported by the reservoir service area. Alternatively, the rancher(s) may reduce the costs associated with the grazing leases on other rangeland. For this analysis, the cost to lease rangeland was assumed to be $1.35 per AUM for federal lands, $3.50 per AUM for state lands and $11.00 per AUM for private lands. Furthermore, it was assumed that the average ranching operation grazing leases consist of 90% federal land, 8% state land and 2% private land. This assumption results in an average cost to lease land of $1.72 per AUM. If a proposed reservoir is located on federal lands, the rancher may realize a reduction in the costs to graze the herd of approximately $0.37 per AUM. Should the proposed reservoir be located on private land, the rancher will realize a reduction of $1.72 per AUM. Finally, if the proposed reservoir is located on state lands, it may not be prudent for the rancher to increase the grazing lease on state lands since it will result in an increase in the grazing costs per AUM and a reduction in the livestock benefits. Table 7 presents the annual livestock benefits associated with each proposed reservoir. The present worth of these benefits was also determined assuming a 25 year life of the structure and 4% inflation rate.
Table 6. Reservoir Yield versus Annual Stock Water Requirements.

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<td>4.9</td>
<td>4.6</td>
<td>4.3</td>
</tr>
<tr>
<td>Pole Gulch 27</td>
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<td>3.8</td>
</tr>
<tr>
<td>Riner 28</td>
<td>170</td>
<td>154</td>
<td>144</td>
</tr>
<tr>
<td>Savery 4</td>
<td>11.1</td>
<td>10.2</td>
<td>9.2</td>
</tr>
<tr>
<td>Savery 18</td>
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<td>11.3</td>
<td>9.8</td>
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<tr>
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<td>96.9</td>
<td>94.7</td>
<td>92.0</td>
</tr>
<tr>
<td>Tullis 6</td>
<td>9.8</td>
<td>9.8</td>
<td>9.7</td>
</tr>
<tr>
<td>Tullis 30</td>
<td>8.1</td>
<td>8.0</td>
<td>8.0</td>
</tr>
</tbody>
</table>
Table 7. Livestock Benefits for Proposed Reservoirs.

<table>
<thead>
<tr>
<th>Reservoir Identifier</th>
<th>AUMs</th>
<th>Ownership</th>
<th>Annual Benefits ($$)</th>
<th>Present Worth ($$$)</th>
<th>Benefit/ AUM ($$$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baggs 27</td>
<td>190</td>
<td>Federal</td>
<td>844</td>
<td>13,180</td>
<td>69</td>
</tr>
<tr>
<td>Blue Gap 16</td>
<td>210</td>
<td>Federal</td>
<td>932</td>
<td>14,570</td>
<td>69</td>
</tr>
<tr>
<td>Blue Gap 27</td>
<td>268</td>
<td>Federal</td>
<td>1,190</td>
<td>18,590</td>
<td>69</td>
</tr>
<tr>
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<td>126</td>
<td>Federal</td>
<td>560</td>
<td>8,740</td>
<td>69</td>
</tr>
<tr>
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<td>188</td>
<td>Federal</td>
<td>835</td>
<td>13,040</td>
<td>69</td>
</tr>
<tr>
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<td>790</td>
<td>12,350</td>
<td>69</td>
</tr>
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<td>808</td>
<td>12,625</td>
<td>69</td>
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<tr>
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<td>88</td>
<td>Federal</td>
<td>390</td>
<td>6,100</td>
<td>69</td>
</tr>
<tr>
<td>Cottonwood Rim 10</td>
<td>150</td>
<td>Private</td>
<td>3,096</td>
<td>48,365</td>
<td>322</td>
</tr>
<tr>
<td>Dixon 11</td>
<td>218</td>
<td>Federal</td>
<td>968</td>
<td>15,120</td>
<td>69</td>
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<tr>
<td>Dixon 34</td>
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<td>Private</td>
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<td>37,080</td>
<td>322</td>
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<td>Federal</td>
<td>795</td>
<td>12,415</td>
<td>69</td>
</tr>
<tr>
<td>Garden Gulch 3</td>
<td>231</td>
<td>Private</td>
<td>4,768</td>
<td>74,480</td>
<td>322</td>
</tr>
<tr>
<td>Garden Gulch 32</td>
<td>232</td>
<td>Federal</td>
<td>1,030</td>
<td>16,090</td>
<td>69</td>
</tr>
<tr>
<td>Ketchum Buttes 1</td>
<td>190</td>
<td>Federal</td>
<td>844</td>
<td>13,180</td>
<td>69</td>
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<tr>
<td>Ketchum Buttes 3</td>
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<td>Federal</td>
<td>573</td>
<td>8,950</td>
<td>69</td>
</tr>
<tr>
<td>Ketchum Buttes 25</td>
<td>229</td>
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<td>1,017</td>
<td>15,885</td>
<td>69</td>
</tr>
<tr>
<td>Ketchum Buttes 34</td>
<td>143</td>
<td>Private</td>
<td>2,952</td>
<td>46,110</td>
<td>322</td>
</tr>
<tr>
<td>McCarty Ranch 8</td>
<td>167</td>
<td>State</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Peach Orchard Flat 6</td>
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<td>Federal</td>
<td>1,052</td>
<td>16,440</td>
<td>69</td>
</tr>
<tr>
<td>Peach Orchard Flat 34</td>
<td>230</td>
<td>Federal</td>
<td>1,021</td>
<td>15,955</td>
<td>69</td>
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<tr>
<td>Pine Grove Ranch 1</td>
<td>186</td>
<td>State</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Pole Gulch 22</td>
<td>115</td>
<td>Federal</td>
<td>511</td>
<td>7,980</td>
<td>69</td>
</tr>
<tr>
<td>Pole Gulch 27</td>
<td>190</td>
<td>Private</td>
<td>3,922</td>
<td>61,265</td>
<td>322</td>
</tr>
<tr>
<td>Riner 28</td>
<td>194</td>
<td>Federal</td>
<td>861</td>
<td>13,460</td>
<td>69</td>
</tr>
<tr>
<td>Savery 4</td>
<td>138</td>
<td>Private</td>
<td>2,848</td>
<td>44,500</td>
<td>322</td>
</tr>
<tr>
<td>Savery 18</td>
<td>190</td>
<td>Private</td>
<td>3,922</td>
<td>61,265</td>
<td>322</td>
</tr>
<tr>
<td>Smiley Draw 3</td>
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<td>Federal</td>
<td>795</td>
<td>12,415</td>
<td>69</td>
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<tr>
<td>Smiley Draw 27</td>
<td>159</td>
<td>Federal</td>
<td>706</td>
<td>11,030</td>
<td>69</td>
</tr>
<tr>
<td>Tullis 6</td>
<td>151</td>
<td>Private</td>
<td>3,117</td>
<td>48,690</td>
<td>322</td>
</tr>
<tr>
<td>Tullis 30</td>
<td>126</td>
<td>Private</td>
<td>2,600</td>
<td>40,630</td>
<td>322</td>
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</tbody>
</table>
Conversations with the WWDC staff indicated that Public Access has generally been required for new reservoirs and is considered an important criteria for the evaluation of proposed stock ponds/reservoir sites. This is especially true if secondary benefits are generated with respect to recreational fisheries and wildlife. Access to each site was initially evaluated with respect to the location of public roads (county or BLM). Consideration was also given to accessibility to the site from public lands versus crossing private property (thereby requiring an easement).

*Project Costs* are always considered an important item in water development projects. For this Level II project, the costs associated with construction of a stock pond/reservoir are dependent on the size of the embankment, spillway requirements including need for stabilization measures, access for construction, materials suitability/availability with respect to embankment and spillway construction, legal/administration costs, engineering costs and permitting costs. Materials suitability/availability may significantly impact project costs due to the distance from an acceptable borrow source to the location of the stock pond/reservoir. Estimates of the costs associated with construction were developed and a unit cost per acre-foot of reservoir capacity determined for each site. The relative comparison of construction costs associated with each stock pond/reservoir site is based on a unit cost of $1,000 per acre-foot. Those sites with unit costs less than $1,000 per acre-foot are considered the most favorable, sites ranging from $1,000 to $3,000 are moderately favorable, while those sites greatly exceeding $3,000 per acre-foot are the least favorable. Table 8 presents the project cost information utilized to evaluate the stock ponds/reservoirs.

The potential for storing water for irrigation was also identified during a discussion with Mr. Hicks. While it is acknowledged that this would create additional tangible benefits associated with each stock pond/reservoir site, it was determined that additional costs will be incurred to construct the facilities necessary to irrigate the adjacent rangeland. Consequently, the costs were assumed to offset the benefits and this evaluation criteria was not investigated further.

**10.2.2 Secondary Evaluation Criteria**

The number of *Project Beneficiaries* is typically an important factor in all water development projects. The beneficiaries associated with each site are identified for this Level II project. Those sites with multiple beneficiaries receive the most favorable rating while a single beneficiary receives the least favorable rating.

*Wildlife and Wetland Benefits* are identified as an important secondary evaluation criteria. Each site is evaluated for potential development or loss of riparian habitat, potential habitat function and value, and potential for improvements in water quality. Those sites with the most potential for improving these values are considered the most favorable while those sites with limited potential receive the least favorable rating. Table 5 summarizes the results of the evaluation.
Table 8. Cost per Acre-Foot for Proposed Reservoirs.

<table>
<thead>
<tr>
<th>Reservoir Identifier</th>
<th>Project Costs ($)</th>
<th>Capacity (AF)</th>
<th>Cost/Acre-Foot</th>
<th>Cost/AUM ($)</th>
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<tbody>
<tr>
<td>Baggs 27</td>
<td>36,050</td>
<td>35.8</td>
<td>1,010</td>
<td>190</td>
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<td>Blue Gap 16</td>
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<td>375</td>
<td>865</td>
<td>&gt;1,500</td>
</tr>
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<td>109</td>
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<td>1,475</td>
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<td>68.8</td>
<td>2,940</td>
<td>&gt;1,500</td>
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<td>3,640</td>
<td>287</td>
</tr>
<tr>
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<td>463</td>
</tr>
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<td>Browns Hill 21</td>
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<td>17.0</td>
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<td>218</td>
</tr>
<tr>
<td>Browns Hill 27</td>
<td>69,250</td>
<td>38.5</td>
<td>1,800</td>
<td>787</td>
</tr>
<tr>
<td>Cottonwood Rim 10</td>
<td>30,850</td>
<td>10.5</td>
<td>2,940</td>
<td>206</td>
</tr>
<tr>
<td>Dixon 11</td>
<td>131,000</td>
<td>76</td>
<td>1,720</td>
<td>601</td>
</tr>
<tr>
<td>Dixon 34</td>
<td>44,500</td>
<td>15.0</td>
<td>2,970</td>
<td>387</td>
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<tr>
<td>Doty Mountain 5</td>
<td>77,150</td>
<td>40.2</td>
<td>1,930</td>
<td>431</td>
</tr>
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<td>13.7</td>
<td>3,040</td>
<td>180</td>
</tr>
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<td>350</td>
<td>854</td>
<td>1,290</td>
</tr>
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<td>Ketchum Buttes 34</td>
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<td>19.3</td>
<td>1,820</td>
<td>146</td>
</tr>
<tr>
<td>McCarty Ranch 8</td>
<td>35,650</td>
<td>8.0</td>
<td>4,460</td>
<td>213</td>
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<td>2,750</td>
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</tr>
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<td>1,189</td>
<td>310</td>
<td>&gt;1,500</td>
</tr>
<tr>
<td>Pine Grove Ranch 1</td>
<td>52,650</td>
<td>55.8</td>
<td>940</td>
<td>283</td>
</tr>
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<td>7,500</td>
<td>326</td>
</tr>
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<td>4.0</td>
<td>17,300</td>
<td>365</td>
</tr>
<tr>
<td>Riner 28</td>
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<td>325</td>
<td>840</td>
<td>1,414</td>
</tr>
<tr>
<td>Savery 4</td>
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<td>11.3</td>
<td>3,220</td>
<td>264</td>
</tr>
<tr>
<td>Savery 18</td>
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<td>39.3</td>
<td>1,930</td>
<td>399</td>
</tr>
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<td>Smiley Draw 3</td>
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<td>12.8</td>
<td>2,840</td>
<td>203</td>
</tr>
<tr>
<td>Smiley Draw 27</td>
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<td>97.5</td>
<td>2,830</td>
<td>&gt;1,500</td>
</tr>
<tr>
<td>Tullis 6</td>
<td>47,150</td>
<td>9.8</td>
<td>4,810</td>
<td>312</td>
</tr>
<tr>
<td>Tullis 30</td>
<td>38,700</td>
<td>8.1</td>
<td>4,450</td>
<td>307</td>
</tr>
</tbody>
</table>
The potential for *Wetland Banking Opportunities* is also evaluated at each stock pond/reservoir site. Initially, the potential number of acres created and considered eligible for the wetland bank is estimated. The successful establishment of wetlands at each site is also dependent on environmental factors such as precipitation, evaporation, sedimentation rates, soil conditions and seepage. Those sites where the environmental factors do not tend to inhibit the formation of self-sustaining wetlands suitable for banking receive a more favorable rating. At these locations, the larger number of potential wetland acres, the more favorable the rating. Where environmental factors tend to inhibit self-sustaining wetlands, a less favorable rating is assigned. Table 5 presents the results of the evaluation.

*Permitting Requirements/Environmental Constraints* associated with each stock pond/reservoir are initially evaluated. It is assumed for this evaluation that individual permit applications would be submitted for each site. Consideration is given to those sites where agricultural exemptions may apply or nationwide or individual permits may be required. In addition, consideration is also given to those sites located on federal lands where completion of an environmental assessment may be required. The most favorable rating is assigned to those stock ponds/reservoir sites which involve the least effort in obtaining the necessary permits.

*Recreational/T&E and Sensitive Species Fishery Benefits* are also evaluated for each stock pond/reservoir site. Creation of habitat for recreational trout fisheries is based on a minimum depth of 10 feet and a surface area of at least 1 acre. A determination of self-sustaining recreational fisheries versus fisheries where annual stocking requirements are incurred is based on a cursory evaluation of streams where trout populations presently occur. The creation of habitat for candidate T&E species (roundtail chubs, flannel mouth suckers, and blue head suckers) is also evaluated. The most favorable rating is assigned to those sites where the greatest fishery benefits were identified. Sites with minimal benefits to fisheries receive the least favorable rating. The evaluation of this criteria is summarized in Table 5.

The *Potential for Alternative or Supplemental Funding* is also included as an evaluation criteria for this Level II project. Funds obtained from alternative sources can potentially increase the number of stock ponds/reservoir sites constructed. This is especially noteworthy in consideration of the Districts’ ability to pay for construction of the stock ponds/reservoir sites. The District has a successful history of obtaining matching funds from alternative sources to construct similar stock ponds/reservoir sites. At those sites where the greatest potential increase in wildlife/wetland benefits or fishery benefits exists, the greatest potential for alternative funding also exists. Those sites where limited wildlife/wetland benefits and fishery benefits have been identified will likely benefit the least from the alternative funding sources.
10.2.3 Reservoir Evaluation

The primary evaluation criteria tend to serve the primary purpose of the project; i.e., to meet requirements for livestock watering and improvements to rangeland. Secondary evaluation criteria are developed to assess the benefits associated with the potential increase in wildlife habitat, wetland development, and fisheries. Each criterion is assigned a weighting factor which indicates the importance of the criterion in the evaluation process. The weighting factors range from a value of 1 (less important) to a value of 3 (most important). All primary evaluation criteria are assigned a weighting factor of 3 which is consistent with the primary purpose of this Level II project. A weighting factor of 2 is assigned to project beneficiaries, wildlife/wetland benefits, and potential for alternative or supplemental funding. The weighting factor of 1 is assigned to the remaining criteria. Finally, the capability of a given stock pond/reservoir site with respect to each evaluation criterion is generally determined on a scale which ranged from 1 (least favorable) to 3 (most favorable). Table 9 presents the results of the reservoir evaluation.

The results of the reservoir evaluation were presented and discussed with representatives of the District and the WWDC. All reservoirs which scored a value of “40” or greater were considered feasible for Level III design and construction. Using this selection criteria, seventeen (17) reservoirs were identified. Of these seventeen reservoirs, the District selected twelve (12) for consideration for Level III design and construction funding. The twelve reservoirs selected by the District included the following:

- Blue Gap 16
- Blue Gap 27
- Browns Hill 21
- Garden Gulch 3
- Garden Gulch 32
- Ketchum Buttes 25
- Ketchum Buttes 34
- Peach Orchard Flat 34
- Pine Grove Ranch 1
- Pole Gulch 27
- Riner 28
- Smiley Draw 27

10.3 Conceptual Design

Based on the review of existing design criteria, conceptual design details of the proposed reservoirs were prepared. The design of the embankment and spillway structures incorporated the following items.
Table 9. Reservoir Evaluation Matrix.

<table>
<thead>
<tr>
<th>Reservoir Identifier</th>
<th>Reliable Water Source</th>
<th>Livestock Benefits</th>
<th>Public Access</th>
<th>Project Cost</th>
<th>Project Beneficiaries</th>
<th>Wildlife/Wetland Benefits</th>
<th>Wetland Banking Benefits</th>
<th>Permitting/Environmental Requirements</th>
<th>Recreational/T&amp;E Species Benefits</th>
<th>Alternative Funding Potential</th>
<th>Total Score</th>
</tr>
</thead>
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<td>3</td>
<td>2</td>
<td>6</td>
<td>3</td>
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<td>2</td>
<td>2</td>
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</tr>
<tr>
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<td>3</td>
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<td>1</td>
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<td>6</td>
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<td>2</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
<td>29</td>
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<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
<td>44</td>
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<tr>
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<td>3</td>
<td>9</td>
<td>3</td>
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<td></td>
<td>43</td>
</tr>
<tr>
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<td>3</td>
<td>3</td>
<td>9</td>
<td>3</td>
<td>2</td>
<td>2</td>
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<td>2</td>
<td></td>
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</tr>
<tr>
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<td>2</td>
<td>6</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td>46</td>
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<td>9</td>
<td>3</td>
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<td>2</td>
<td>3</td>
<td>1</td>
<td></td>
<td>45</td>
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<td>2</td>
<td>6</td>
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<td>2</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td></td>
<td>49</td>
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<td>9</td>
<td>3</td>
<td>3</td>
<td>1</td>
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Ranking: 1 - Least Favorable 2 - Moderately Favorable 3 - Most Favorable
• 4H:1V and 2H:1V upstream and downstream embankment slopes, respectively;

• Emergency spillway capacity to convey the peak discharge associated with the 25-year flood event;

• Where feasible, principal spillway (pipe spillway) capacity sufficient to convey the peak discharge with the 2-year flood event; in all cases the maximum diameter of the principal spillway was limited to 24 inches and the minimum diameter was restricted to 12 inches.

• Placement of rock riprap to ensure the stability of the emergency spillway and embankment; rock is identified for placement at the confluence of the emergency spillway and the receiving drainage channel, between the confluence and crest of the emergency spillway, along the crest of the emergency spillway, and at the outfall from the principal spillway.

• Installation of a core trench to reduce potential seepage beneath the embankment.

• Minimum dam crest width of 8 feet.

• Minimum freeboard of 5 feet between crest of emergency spillway and crest of embankment.

Figure 6 presents typical conceptual details for construction of the reservoir along with pertinent reservoir data for each proposed reservoir. It should be noted that a detailed subsurface exploration program should be completed prior to construction of any of the proposed reservoirs. Results from the subsurface exploration program may change the design of the core trench or identify requirements for additional seepage reduction measures.

10.4 Cost Estimates

Based on the conceptual design details and the plan view of each reservoir site provided in Appendix G, detailed cost estimates for the construction of the proposed reservoirs were prepared. These cost estimates were based on the unit costs itemized below.

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<th>Unit Cost</th>
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Detailed cost estimates of the construction costs assigned to each proposed reservoir are presented in Table 10. The cost estimates include 15% for construction contingencies and 10% for both engineering during construction and preparation of final plans and specifications. Delineation of the existing wetlands has been included in the costs for final plans and specifications. The cost for additional geotechnical services has been included and was estimated to be approximately $3,000 per site. Permitting costs largely reflect the effort required to prepare submittals to the Corps of Engineers (Section 404).
Table 10. Detailed Cost Estimates for Proposed Reservoirs.

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<th>Engineering (10%)</th>
<th>Final Plans/Specs (10%)</th>
<th>Permitting/Mitigation</th>
<th>Legal Fees</th>
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<td>750</td>
<td>500</td>
<td>500</td>
<td>3,000</td>
<td>47,150</td>
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</tr>
<tr>
<td>Tullis 30</td>
<td>24,650</td>
<td>3,700</td>
<td>28,350</td>
<td>2,800</td>
<td>750</td>
<td>500</td>
<td>500</td>
<td>3,000</td>
<td>38,700</td>
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</tr>
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</table>
XI. PERMITS AND ENVIRONMENTAL STUDIES

11.1 General

Prior to construction of the stock ponds or reservoirs, several permits and/or environmental studies may be required to ensure that construction is completed in compliance with all applicable environmental laws. These requirements fall under the jurisdiction of several federal and state agencies including, but not necessarily limited to the Wyoming Department of Environmental Quality, Wyoming State Engineer’s Office, Wyoming State Board of Control, U. S. Bureau of Land Management, U. S. Army Corps of Engineers, State Historic Preservation Office, Wyoming Game and Fish Department and U.S. Fish and Wildlife Service. Compliance with Section 404 of the Clean Water Act involves the majority of the agencies. Other regulations also apply to the construction of the stock ponds or reservoirs including, but not limited to the National Environmental Policy Act (NEPA), National Historic Preservation Act (NHPA), and the Endangered Species Act (ESA). In general, compliance with Section 404 of the Clean Water Act often includes compliance with NEPA, NHPA and the ESA.

A meeting was conducted on October 1, 1997 to specifically discuss the permitting requirements associated with construction of the reservoirs. The following people were present at the meeting:

Chris Abernathy                  Wyoming Department of Environmental Quality (WDEQ)
Steve Adams                     Little Snake River Conservation District (District)
Jack Cobb                       District
Larry Hicks                     District
John Barnes                     Wyoming State Engineer’s Office (SEO)
Mike Carnevale                  Wyoming Water Development Commission (WWDC)
Bill DiRienzo                   WDEQ
Chandler Peter                  U.S. Army Corps of Engineers (COE)
Chuck Reed                      U.S. Bureau of Land Management (BLM)
Dave Ruiter                     U.S. Environmental Protection Agency (EPA)
Steve Wolf                      Wyoming Game and Fish Department (WGFD)
Karen Classi                    TRC Mariah Associates, Inc.
Brad Anderson                   Lidstone & Anderson, Inc.

The results of the meeting were summarized in a memorandum prepared by Ms. Karen Classi and dated November 7, 1997. This following paragraphs specifically discuss the permitting issues associated with this project.
11.2 Compliance with Section 404 of the Clean Water Act

Section 404 of the Clean Water Act regulates the placement of dredged or fill material into water of the U.S., including wetlands. If elevated to Level III status, this project would involve the construction of dams across drainages or swales, some of which are likely to be waters of the U.S. and may contain wetlands. Consequently, construction of the stock ponds or reservoirs would require authorization or permits from the Corps of Engineers (COE).

To date, three possible authorization/permitting scenarios have been identified.

- Application of the agricultural exemption.
- Authorization under a Nationwide Permit (NWP). NWP 26 allows placement of dredged or fill material resulting in the disturbance of up to 3.0 acres of waters of the U.S.
- Issuance of an Individual Permit (IP).

To permit the project, the following information should be submitted to the COE for each site (Personal communication with Chandler Peter, U.S. Army Corps of Engineers, Wyoming Regulatory Office, October and November 1997).

- Proposed stock pond location (map).
- Typical diagrams illustrating stock pond configuration and design characteristics.
- A description of the purpose and need for the stock pond (this description should include the storage capacity and livestock numbers associated with individual ponds; proposals to bank any wetlands created by the project; and opportunities for wildlife habitat improvements, if any).
- Location and acreage of jurisdictional wetlands and water of the U.S. that would be affected by the proposed stock pond.
- Area of inundation or impoundment.

If development of a stock pond would disturb a substantial quantity of wetlands, an analysis of possible alternative locations may be required. Additional information may be required on a case-by-case basis, but the information described above should provide the COE with sufficient data to determine permitting requirements. Once these data have been submitted, a determination of sites...
which qualify for the agricultural exemption and which may need authorization under a NWP or IP can be determined.

11.2.1 Applicability of the Agricultural Exemption

Generally, the agricultural exemption permits stock pond construction in waters of the U.S. (33 CFR Part 323.4(a)(3) of the Federal Register, Volume 51, No. 219 dated November 13, 1986). The exemption is only permitted, however, if the sole purpose of the stock pond is for livestock watering ("A pond is only exempt to the size the farmer requires to meet normal farming operations", U.S. Army Corps of Engineers, Omaha District, Regulatory Guidance Letter 95-06 dated February 2, 1996). Consequently, storage capacity of the stock pond design may preclude the application of the agricultural exemption. If the ponds are designed for a storage capacity that is substantially larger than required to support the anticipated number of livestock, it is unlikely that the pond will qualify for the agricultural exemption (Personal communication with Chandler Peter, November 1997).

In addition to livestock watering, the Little Snake River Conservation District (District) is interested in obtaining wetland banking credits under Wyoming’s Statewide Wetland Mitigation Bank for any wetlands that are created by new stock pond construction. The District would also like to promote wildlife use of the ponds as well as fishery enhancement. However, with “multiple use” as a stated objective of pond development (as compared to livestock watering as the sole purpose of the pond), the agricultural exemption may not be applied and Section 404 compliance would require authorization under a NWP or IP.

Given that the District may wish to maximize the potential storage at each site along with providing potential benefits to wildlife, wetlands and fisheries, only a limited number of stock ponds are likely to qualify for the agricultural exemption.

11.2.2 Nationwide versus Individual Permit

The COE is authorized to approve certain types of projects under a NWP, if the project meets the criteria and general conditions of a given NWP. NWP 26 is frequently used to authorize projects such as stock pond construction in headwater areas and requires that no more than 3.0 acres be disturbed in any waters of the U.S. including wetlands (Joint Public Notice, U.S. Army Corps of Engineers and Wyoming Department of Environmental Quality, “Nationwide Permits”, May 7, 1997). On a site-by-site basis, few of the proposed stock ponds would cause this threshold to be exceeded. Thus the project may possibly be permitted by submitting separate, site-by-site
applications for coverage under a NWP (i.e., submitting applications for each stock pond/reservoir). However, federal agencies are presently avoiding a “piecemeal approach” to projects and are evaluating the cumulative impacts associated with construction of several projects within a basin or watershed (General Condition 15 to Nationwide Permits as presented in Joint Public Notice, U.S. Army Corps of Engineers and Wyoming Department of Environmental Quality, “Nationwide Permits”, May 7, 1997). Consequently, the COE may view the project as consisting of the construction of several stock ponds and an IP would then be required. If an IP is required, a single application could be submitted for construction of all of the stock ponds. Should future stock ponds be required, the IP can be modified and no new permit application would be necessary. Furthermore, maintenance activities associated with stock ponds permitted through an IP may also be allowed (Personal communication with Chandler Peter, U.S. Army Corps of Engineers, Wyoming Regulatory Office, November 1997).

11.2.3 Depletions

The proposed construction of stock ponds would result in depletions in the Little Snake River watershed, a situation that the U.S. Fish & Wildlife Service (USFWS) has determined is likely to jeopardize threatened and endangered (T&E) fish species. As a reasonable and prudent alternative to the jeopardy opinion, the USFWS has implemented a fee requirement for any depletions in the basin. For projects that results in depletions of less than 100 acre-feet, the fee is typically waived; the fee for depletions greater than 100 acre-feet is paid during the first year of depletion (Personal communication with Dave Felley, USFWS, November 1997).

The COE regulations state that no project that is likely to jeopardize T&E species can be permitted under a NWP unless a reasonable and prudent alternative to the jeopardy opinion is implemented. If the USFWS waives the fee requirement or the project proponent pays the depletion fee, a project may be permitted under a NWP; otherwise, an IP would be required. During the review of the permit application, the issue associated with potential impacts of cumulative depletions may be raised by the U.S. Fish & Wildlife Service and may need to be addressed (Personal communication with Chandler Peter, U.S. Army Corps of Engineers, Wyoming Regulatory Office, November 1997).
11.2.4 Summary

Based on existing information related to the project that was presented to the representatives of the Wyoming Regulatory Office, it is highly likely that the necessary permits can be obtained to achieve compliance with Section 404 of the Clean Water Act. For Section 404 permitting, the level of effort and expense increase from application of the agricultural exemption to applying for an IP. The number of stock ponds eligible for the agricultural exemption may be limited. It is more likely that a NWP for the majority of the ponds will be required. The limitations associated with General Condition 15 to NWP 26 (impact of single versus multiple projects in a watershed) may limit the submittal of individual applications and may ultimately require that an IP application be submitted. Application for an IP which would encompass construction of all of the proposed stock ponds may be more costly but may also offer advantages with respect to the flexibility to construct additional ponds in the future and may allow for maintenance activities associated with the stock ponds.

Finally, where a federal permit is required (i.e., a NWP or IP) and/or federal land is involved (such as stock ponds located on BLM property), compliance with NEPA, the NHPA and the ESA (as well as other federal, state and local laws) will be triggered. Consequently, construction of stock ponds/reservoirs on BLM land will require completion of an Environmental Assessment (EA). The EA can be completed to encompass all of the proposed stock ponds within the Little Snake River Basin (Personal communication with Bill Waters, Bureau of Land Management, April 1998).

11.3 Wyoming Game and Fish Department

Formal approval of the proposed reservoirs will be required from the Wyoming Game and Fish Department. This will be accomplished through the Section 404 permit process.

11.4 U.S. Fish & Wildlife Service

The U.S. Fish and Wildlife Service (USFWS) will take an active role in the Section 404 permit process. This federal agency will perform the Section 7 consultation for threatened and endangered species. As stated previously, as a reasonable and prudent alternative to the jeopardy opinion, the USFWS has implemented a fee requirement for any depletions in the basin. For projects that result in depletions of less than 100 acre-feet, the fee is typically waived; the fee for depletions greater than 100 acre-feet is paid during the first year of depletion.
11.5 Wyoming DEQ/Water Quality Division

If a Section 404 permit is required, the State of Wyoming will require Section 401 authorization. A permit to construct will be required along with a plan to control water quality during construction.

11.6 State Historic Preservation Office

Formal approval from the State Historic Preservation Office is required as part of the Section 404 permit process. To expedite the process, a cultural resource inventory of the proposed reservoir areas should be requested.

11.7 Wyoming State Engineer’s Office

Plans and specifications detailing the construction of the proposed reservoirs must be filed with the State Engineer’s Office (SEO). The necessary permits must be completed and submitted.

11.8 U.S. Bureau of Land Management

If federal land is involved in construction of the proposed reservoirs or a federal permit is required (i.e., a NWP or IP), compliance with NEPA, the NHPA and the ESA (as well as other federal, state and local laws) will be triggered. Consequently, construction of stock ponds/reservoirs on BLM land will require completion of an Environmental Assessment (EA). The EA can be completed to encompass all of the proposed stock ponds within the Little Snake River Basin. Formal approval of the proposed reservoirs will be required from the BLM. This will be accomplished through the Section 404 permit process.

11.9 Land Ownership and Property Owners

Where applicable, permission should be negotiated for right-of-access for all construction activities associated with the project. All easements should be obtained prior to construction.
XII. ECONOMIC ANALYSIS

12.1 General

An economic analysis was completed to assess the ability of the District to pay for the water made available from construction of the proposed reservoirs. Presently, the District assesses all property owners through a mill levy. The mill levy generates approximately $110,000 per year which is utilized to cover the operation and maintenance costs associated with the District. Limited funds are available for allocation to the construction of the ponds/reservoirs.

At the request of the WWDC, a legal review of the laws pertaining to Conservation Districts was completed. Specific attention was devoted to the qualifications of Conservation Districts as project sponsors. This issue was investigated by Ms. Kate Fox of Davis & Cannon. A summary of her work is provided below.

The legal nature of a conservation district gives it dubious qualifications as a project sponsor. Conservation districts are authorized pursuant to Wyo. Stat. §§11-16-101 et seq. The laws impose two severe limitations on their ability to make long-term financial commitments. First, Wyo. Stat. § 11-16-123(b) provides that no contract entered into by a district is valid if it commits to payment of money in excess of the district's assets at the time the contract is made. Second, conservation districts get their income by taxing their members, and the imposition of the tax can be defeated by general election of the members (Wyo. Stat. § 11-16-134(c)). There is no assurance the LSRCD would have the continued financial ability to maintain this project, much less repay a loan in any amount.

Prior to advancing this project to Level III status, the issue related to the qualifications of the District as a project sponsor must be resolved.

12.2 Financing Plan

The results of the reservoir evaluation in Table 9 were utilized to select those reservoirs with the greatest potential for construction. These reservoirs include Blue Gap 16, Blue Gap 27, Browns Hill 21, Garden Gulch 3, Garden Gulch 32, Ketchum Buttes 25, Ketchum Buttes 34, Peach Orchard Flats 34, Pine Grove Ranch 1, Pole Gulch 27, Riner 28, and Smiley Draw 27. Assuming construction of all twelve reservoirs, a repayment plan was formulated. The repayment plan was based on a 60% grant and 40% loan from the WWDC. The term of the loan was assumed to be 20 years with an interest rate of 7.25 percent. The repayment plan is presented in Table 11.
Table 11. Repayment Plan.

| Cost of Project Improvements (All Reservoirs) | 2,254,650 |
| 40% Loan | 901,860 |
| Repayment Factor (20 Years @ 7.25%) | 0.09626 |
| Annual Payment on Loan | 86,815 |
| Annual Operation and Maintenance Cost | 5,000 |
| Annual Cost to District | 91,815 |

Annual operation and maintenance costs were also included in Table 11. It is likely that the proposed reservoirs will require annual monitoring and maintenance to ensure the longevity of each structure. These activities may include removal of sediment accumulated in the reservoir or maintenance of wetlands established for inclusion in the State Wetland Bank. An annual cost of $5,000 was assumed for operation and maintenance expenses.

As indicated in Table 11, the total annual cost to the District for construction of the proposed reservoirs is estimated to be $91,815. This amount assumes no monies are available from alternative funding sources. Funding from the alternative sources could significantly reduce or eliminate the loan amount of $901,860.

12.3 Alternative Funding Sources

As indicated previously, the District has limited funds available to allocate for the construction of the ponds/reservoirs. To date, Mr. Hicks has been very successful in obtaining monies for the construction of these ponds/reservoirs from a variety of funding sources. The funding sources have included Ducks Unlimited; Wyoming Game and Fish Department (trust fund grants); EPA 319 monies; state farm bill program; Water for Wildlife; and the Pronghorn Foundation. Money from these sources have resulted in construction of the ponds/reservoirs without an increase in the mill levy associated with the District. Recent conversations with Mr. Hicks have indicated that funds continue to be available from these sources. It is likely that matching funds will be obtained for that portion of a Level III appropriation which consists of the loan obligation. It should be noted, however, that the annual operating and maintenance costs will not likely be covered by the monies available from the alternative funding sources.
APPENDIX A

INVENTORY FORMS
<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Baggs 27</th>
<th>Stream: Poison Draw</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 27</td>
<td>Contributing Drainage Area: 3.8 Sq. Mi.</td>
<td></td>
</tr>
<tr>
<td>Township 13</td>
<td>Reservoir Service Area: 760 Acres</td>
<td></td>
</tr>
<tr>
<td>Range 92</td>
<td>Ownership:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Federal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>State</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Private</td>
<td></td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**
- Borrow Source: 
- Foundation: 

**Accessibility (Location & Description):**
- Two track from County Road 700 across public lands

**Topographic Considerations:**
- Approximate Capacity: 35.8 Acre Feet
- Approximate Dam Height: 20'
- Approximate Dam Length: 150'

**Existing Wetlands:**
- Appears to be some in the low flow channel

**Wetland Enhancement Potential:** Minimal

**Wildlife/Fishery Potential:** Possible

**Potential Project Beneficiaries:**
1. Pilgrim, Roger J.
2. 
3. 
4. 

**Attached Information:**
- Location Map
- Photographic Documentation
- Topographic Sketch
- Survey Data
- Other
RESEVOIR INFORMATION FORM

Reservoir Description: Baggs 27

Date of Inventory: August 24, 1997

Reservoir Location (1/4, Section, Township, Range): NWSW 1/4 Section 27, T13N, R92W

Drainage Name: Poison Draw

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent

Source (Runoff, Springs, etc.): Probably runoff from drainage area

Terrain (flat, rolling, etc.): Gentle rolling hills

Range description: Sparse grass with considerable sagebrush

Range Condition: Fair

Description of Contributing Water Sources for Range Management: Two BLM Reservoirs within the drainage

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM reservoir approximately ½ mile up Poison Draw (S27, T13N, R92W)
2. BLM reservoir approximately 1 ½ miles up Poison Draw (S26, T13N, R92W)

Springs: None identified

Photo Log:

Film No. 1

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<tr>
<td>1</td>
<td>Upstream Drainage</td>
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<tr>
<td>2</td>
<td>Downstream Drainage</td>
</tr>
<tr>
<td>3</td>
<td>Channel Vegetation at Dam Site</td>
</tr>
<tr>
<td>4</td>
<td>General Site from West Rim</td>
</tr>
<tr>
<td>5</td>
<td>Upper Drainage</td>
</tr>
</tbody>
</table>

Little Snake River - Baggs 27
RESERVOIR INFORMATION FORM

Access: Access for the inventory information was by two track off of county road 700 west of Poison Draw. The two track crosses both public and private property and extends to the top of the draw. From the top of the ridge to the site was crossed on foot.

Location: The east side of the drainage is relatively steep with a more moderate side slope on the west side. The channel has some erosion and is cut into the drainage. The channel was dry at the time of the inventory and it appears that the source of water for the reservoir would be from runoff. The emergency spillway is proposed along the west side of the drainage and is to tie into a tributary of Poison Draw.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[5,000' \times 4,000' + 3,750 \times 3,500 = 760\text{ acres}\]

Assumptions for Service Area:

- BLM Reservoir ½ mile upstream
- Steep ridges on east and west side of drainage
- Service area approximately ½ mile around reservoir except the service area was extended to 1 mile down stream.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

<table>
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<th>Location:</th>
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<tr>
<td>Section</td>
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<tr>
<td>Township</td>
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<td>Range</td>
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<table>
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<tr>
<th>Description of Soil Suitability:</th>
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<tr>
<td>Borrow Source:</td>
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<td>Foundation:</td>
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</table>

<table>
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<tr>
<th>Accessibility (Location &amp; Description):</th>
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<tr>
<td>Proposed reservoir site is adjacent to County Road 608</td>
</tr>
<tr>
<td>Potential Project Beneficiaries:</td>
</tr>
<tr>
<td>1. Montgomery Livestock</td>
</tr>
<tr>
<td>2. Snake River Land Co.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
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</table>

<table>
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<tr>
<th>Topographic Considerations:</th>
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<tr>
<td>Approximate Capacity: 375 Acre Ft.</td>
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<td>Approximate Dam Height: 20'</td>
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<td>Approximate Dam Length: 1152'</td>
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<table>
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<th>Existing Wetlands:</th>
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<td>(Description, Acreage)</td>
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<td>Appears to be some in low flow channel</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Wetland Enhancement Potential:</th>
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<tbody>
<tr>
<td>Good if source is sufficient</td>
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<table>
<thead>
<tr>
<th>Wildlife/Fishery Potential:</th>
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<tr>
<td>Poor</td>
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<table>
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<tr>
<th>Attached Information:</th>
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<tr>
<td>Location Map</td>
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<td>Topographic Sketch</td>
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<tr>
<td>Survey Data</td>
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<tr>
<td>Other</td>
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</table>
XIII. CONCLUSIONS AND RECOMMENDATIONS

Based on the work completed in support of the Little Snake River Basin Small Reservoir Development Project-Level II, the following conclusions and recommendations are provided.

1. Several stock ponds and reservoirs have been constructed within the boundaries of the District. Ponds recently constructed by the District have been operating reasonably well. However, erosion problems have been experienced on the upstream embankment of the reservoirs and within the emergency spillways. Sedimentation problems have also been experienced in some of the existing ponds. A severe seepage problem in the embankment of a recently constructed pond was noted during the field inventory.

2. Adherence to design and construction guidelines is recommended to ensure that the reservoirs will be constructed to minimize maintenance of the structures and optimize their longevity. Structures should be designed and constructed to ensure a maximum useful life span of twenty-five (25) years. A geotechnical investigation is recommended prior to the construction of future reservoirs. Professional engineers and geologists (licensed in the State of Wyoming) should be secured for final design, permitting and construction inspection.

3. Construction of the reservoirs may result in the creation of wetlands which are eligible for inclusion in the Wyoming Wetland Bank. Ownership of wetland banking credits belongs to the landowner. If the WWDC is interested in obtaining ownership of these credits, a legal agreement will be required to transfer the ownership of these credits to the District and ultimately the WWDC.

4. The District initially identified 35 reservoir sites for evaluation. Conceptual design details and cost estimates were prepared for 31 reservoir sites following an initial review by the District and WWDC. A detailed evaluation of the 31 reservoir sites resulted in the selection of twelve (12) reservoirs for potential consideration and advancement to Level III construction. These reservoirs include:

- Blue Gap 16
- Blue Gap 27
- Browns Hill 21
- Garden Gulch 3
- Garden Gulch 32
- Ketchum Buttes 25
- Ketchum Buttes 34
- Peach Orchard Flat 34
- Pine Grove Ranch 1
- Pole Gulch 27
- Riner 28
- Smiley Draw 27

The total construction cost was estimated to be $2,254,650. Assuming a 60% grant and 40% loan (20 years @ 7.25%), the annual payment necessary to retire the loan becomes $86,815.
Including an annual operation and maintenance cost of $5,000, the total annual payment incurred by the District is estimated to be $91,815.

The total storage provided by the twelve reservoirs is estimated to be 2,636 acre-feet. This relates to an estimate of $855 per acre-foot assuming construction of the twelve reservoirs.

5. It is likely that the proposed reservoirs will require annual monitoring and maintenance to ensure the longevity of each structure. These activities may include removal of sediment accumulated in the reservoir or maintenance of wetlands established for inclusion in the State Wetland Bank. The District’s present operation and maintenance budget may need to be increased to include the additional expenses.

6. Alternative funding sources are available to either partially or totally offset the loan obligation of $901,860 associated with construction of the twelve reservoirs. The funding sources include, but are not limited to Ducks Unlimited; Wyoming Game and Fish Department (trust fund grants); EPA 319 monies; state farm bill program; Water for Wildlife; and the Pronghorn Foundation. It should be noted, however, that the annual operating and maintenance costs will not likely be covered by the monies available from the alternative funding sources.

7. Based on a review of existing information, it is highly likely that the necessary permits can be obtained to achieve compliance with Section 404 of the Clean Water Act. Either a nationwide permit or individual permit will be required for the majority of the reservoirs. Where a federal permit is required and/or federal lands is involved, compliance with NEPA, the NHPA and the ESA will be triggered. Construction of stock ponds/reservoirs on BLM land will require completion of an Environmental Assessment (EA).

8. Prior to advancing this project to Level III status, the issue related to the qualifications of the District as a project sponsor must be resolved. Specifically, to be eligible for funds, the District must demonstrate that it is a public entity that can incur debt, generate revenues to repay a state loan, hold title to the improvements contemplated by the project, provide security for repaying the anticipated state construction loan, demonstrate operational and maintenance capability, and can legally receive grant funds.
Reservoir Description: Blue Gap 16

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): SESE Section 16, T15N, R91W

Drainage Name: Wild Cow Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at the time of the inventory

Source (Runoff, Springs, etc.): Unknown

Terrain (flat, rolling, etc.): Flat valley in drainage with gentle rolling hills outside the valley

Range description: Sage with some grass in the flood plain of the drainage.

Range Condition: Fair - poor

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM Reservoir approximately ½ mile southeast (Section 22, T15N, R91W)
2. BLM Reservoir approximately 1 mile northeast (Section 15, T15N, R91W)
3. Springs: None identified

Photo Log:

<table>
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<th>Film No. 2</th>
<th>Photo No.</th>
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<tr>
<td></td>
<td>13</td>
<td>Upstream drainage area</td>
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<td></td>
<td>14</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>Channel at proposed dike crossing</td>
</tr>
</tbody>
</table>

Little Snake River - Blue Gap 16
RESERVOIR INFORMATION FORM

Access: The proposed reservoir site is adjacent to County Road 608 and is on public lands.

Location: The proposed reservoir site is located in a flat drainage with a wide valley. The proposed dike can be constructed along the north side of the drainage and tied into a knob in the flood plain area of the drainage. If the dike is raised it will need to be extended to a length of approximately 675 feet. Some flow was present at the time of the inventory and it appeared that wetlands exist along the channel area. The emergency spillway would be that portion of the drainage south of the proposed dike or if the dike extended across the drainage then the spillway can be excavated out of the side hill on the south side of the drainage.

The proposed reservoir has a good potential to create wetlands along the entire shoreline of the reservoir if the water source is sufficient.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

5,000' X 5,500' + (1,500 X 3,000)2 = 837 acres

Service Area Capacity

837 acres / 4 acres per AUM = 209 AUMs

Assumptions for Service Area:

- No contributing water sources
- Steep hills on the north and west sides of the reservoir
- Service area ½ mile north and south of the drainage and 1 mile up and down the drainage
**LITTLE SNAKE RIVER WATER DEVELOPMENT PROJECT - LEVEL II PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Blue Gap 27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
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</tr>
<tr>
<td>Township</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stream:</th>
<th>Cow Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributing Drainage Area:</td>
<td>28.1 Sq. Mi.</td>
</tr>
<tr>
<td>Reservoir Service Area:</td>
<td>1,073 Acres</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description of Soil Suitability:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrow Source:</td>
</tr>
<tr>
<td>Foundation:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ownership:</th>
</tr>
</thead>
<tbody>
<tr>
<td>X Federal</td>
</tr>
<tr>
<td>□ State</td>
</tr>
<tr>
<td>□ Private</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessibility (Location &amp; Description):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir adjacent to BLM Road 3308.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Project Beneficiaries:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Weber Ranch Inc.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Topographic Considerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Capacity</td>
</tr>
<tr>
<td>Approximate Dam Height</td>
</tr>
<tr>
<td>Approximate Dam Length</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Existing Wetlands:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description, Acreage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wetland Enhancement Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Good if source is sufficient</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wildlife/Fishery Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attached Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Location Map</td>
</tr>
<tr>
<td>□ Photographic Documentation</td>
</tr>
<tr>
<td>□ Topographic Sketch</td>
</tr>
<tr>
<td>□ Survey Data</td>
</tr>
<tr>
<td>□ Other</td>
</tr>
</tbody>
</table>

Appears to be some along low flow channel
RESERVOIR INFORMATION FORM

Reservoir Description: Blue Gap 27

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): NESW Section 27, T16N, R91W

Drainage Name: Cow Creek

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent at this location

Source (Runoff, Springs, etc.): Appears to be runoff

Terrain (flat, rolling, etc.): Flat with gentle rolling hills

Range description: Primarily sage with some grass in the channel and along the hill sides

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoir, and springs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:

1. Natural reservoir approximately 1/2 mile Northwest of proposed site.

Springs: Quad shows springs approximately 1/2 mile South of the proposed site.

Photo Log:

Film No. 2

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Drainage area upstream</td>
</tr>
<tr>
<td>8</td>
<td>Drainage area downstream</td>
</tr>
<tr>
<td>9</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Proposed reservoir is adjacent to BLM road 3308

Location: The drainage in the area of the proposed reservoir is flat. The potential to create wetlands appears to high for the entire reservoir if the source is sufficient. The proposed spillway is to be excavated out of the north side slope.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

8,500' X 5,500' = 1,073 acres

Service Area Capacity

1,073 acres / 4 acres per AUM = 268 AUMs

Assumptions for Service Area:

• No contributing water sources
• Rolling terrain in area of reservoir
• Service area ½ mile on east and west side of the reservoir and 1 mile up and down the drainage.
LITTLE SNAKE RIVER  
WATER DEVELOPMENT PROJECT - LEVEL II  
PROJECT INVENTORY FORM

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Bridger Pass 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 6</td>
<td>Stream: Separation Creek</td>
</tr>
<tr>
<td>Township 18</td>
<td>Contributing Drainage Area: 7.6 Sq. Mi.</td>
</tr>
<tr>
<td>Range 89</td>
<td>Reservoir Service Area: 505 Acres</td>
</tr>
</tbody>
</table>

Description of Soil Suitability:
- Borrow Source: ____________________________
- Foundation: _____________________________

Ownership:
- X Federal
- ☐ State
- ☐ Private

Accessibility (Location & Description):
- Two track off of County Road 605 up Jep Canyon.
- Two track crosses public and private lands.

Potential Project Beneficiaries:
1. P.H. Livestock Co.
2. ____________________________
3. ____________________________
4. ____________________________

Topographic Considerations:
- Approximate Capacity: 69 Acre Feet
- Approximate Dam Height: 28'
- Approximate Dam Length: 350'

Existing Wetlands:
- Appears to be wetlands along the channel area

Wetland Enhancement Potential:
- Possibly along reservoir fringes

Wildlife/Fishery Potential:
- Some potential if source is sufficient

Attached Information:
- ☐ Location Map
- ☐ Photographic Documentation
- ☐ Topographic Sketch
- ☐ Survey Data
- ☐ Other ____________________________
Reservoir Description: Bridger Pass 6

Date of Inventory: July 25, 1997

Reservoir Location (1/4, Section, Township, Range): SENE Section 6, T18N, R89W

Drainage Name: Separation Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Probably spring fed (quad shows springs at headwater)

Terrain (flat, rolling, etc.): Rolling (wide valley with steep side hills and ridges on both sides)
Range description: Grass in flood plain and on upper parts of ridges with sage on the side slopes

Range Condition: Good - fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: None identified

Photo Log:

Film No. 1

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Drainage area upstream</td>
</tr>
<tr>
<td>24</td>
<td>Drainage area downstream</td>
</tr>
<tr>
<td>25</td>
<td>Channel at proposed dike crossing</td>
</tr>
</tbody>
</table>

Little Snake River - Bridger Pass 6
Access: Two track from County Road 605 up Jep Canyon to the reservoir site. The two track is approximately 20 miles from Rawlins on County Road 605. Two track crosses private and public lands.

Location: Wide valley with a fairly steep side slope on the South side of the drainage. The proposed site for the reservoir dike has a knob on the North side to tie into and the steep side slope on the south side. The emergency spillway is proposed to be excavated out of the knob on the North side.

The channel is saturated upstream from the proposed dike and the channel is not well defined. There is some potential to create wetlands along the fringes and tail water of the reservoir.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[5,500' \times 5,000' + (1,000 \times 1,000) \times 2 = 677 \text{ acres}\]

Assumptions for Service Area:

- New Bridger Pass 12 and Bridger Pass 32 upstream and down stream
- Steep hills on the north and south sides of the reservoir
- Service area ½ mile around reservoir except the service area was extended to approximately 3,000 feet upstream and downstream.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:
Section 12
Township 18
Range 90

Reservoir Name: Bridger Pass 12
Stream: Separation Creek
Contributing Drainage Area: 9.5 Sq. Mi.
Reservoir Service Area: 750 Acres

Description of Soil Suitability:
Borrow Source: Federal
Foundation: Private

Ownership:
X Federal
□ State
□ Private

Accessibility (Location & Description):
Two track off of County Road 605 up Jep Canyon

Potential Project Beneficiaries:
1. P.H. Livestock
2. 
3. 
4. 

Topographic Considerations:
Approximate Capacity 15 Acre Feet
Approximate Dam Height 20'
Approximate Dam Length 250'

Existing Wetlands:
Possibly along low flow channel

Wetland Enhancement Potential:
Some along fringes of reservoir

Wildlife/Fishery Potential:
Possible

Attached Information:
□ Location Map
□ Photographic Documentation
□ Topographic Sketch
□ Survey Data
□ Other ____________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Bridger Pass 12

Date of Inventory: July 25, 1997

Reservoir Location (1/4, Section, Township, Range): SENE Section 12, T18N, R90W

Drainage Name: Separation Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Probably spring fed (quad shows springs at headwater)

Terrain (flat, rolling, etc.): Rolling (wide valley with steep side hills and ridges on both sides)
Range description: Grass in flood plain and on upper parts of ridges with sage on the side slopes

Range Condition: Good - fair

Description of Contributing Water Sources For Range Management: Spring

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: One spring shown on quad approximately ½ mile southwest of reservoir in the same section

Photo Log:

Film No. 1

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Drainage area upstream</td>
</tr>
<tr>
<td>20</td>
<td>Drainage area downstream</td>
</tr>
<tr>
<td>21</td>
<td>Channel at proposed dike crossing</td>
</tr>
<tr>
<td>22</td>
<td>Generally range at proposed dike area</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track from County Road 605 up Jep Canyon to the reservoir site. The two track is approximately 20 miles from Rawlins on County Road 605. Two track crosses public and private lands.

Location: Wide valley with a fairly steep side slope on the South side of the drainage. The valley has a moderate slope along the North side to the steep side slope of the North ridge. The emergency spillway is proposed to be excavated out of the moderate slope along the North side of the valley.

The channel is not saturated and is well defined in the area of the reservoir. There is some potential to create wetlands along the fringes and tail water of the reservoir.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[3,500' \times 2,000' + 2,000 \times 1,000 + 3,200 \times 2,000 + 1,500 \times 1,500 = 750 \text{ acres}\]

Assumptions for Service Area:

- New Bridger Pass 6 upstream from reservoir
- Steep hills on the north and south sides of the reservoir
- Service area \(\frac{1}{2}\) mile around reservoir except the service area was extended to a mile down stream and approximately 3,000 feet up stream.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:
Section 32
Township 19
Range 89

Reservoir Name: Bridger Pass 32
Stream: Separation Creek
Contributing Drainage Area: 4.8 Sq. Mi.
Reservoir Service Area: 712 Acres

Description of Soil Suitability:
Borrow Source: ________________________________
______________________________
______________________________
Foundation: ________________________________
______________________________
______________________________

Ownership:
X Federal
□ State
□ Private

Accessibility (Location & Description):
Two track off of County Road 605 up Jep Canyon.
Two track crosses public and private lands.

Potential Project Beneficiaries:
1. P.H. Livestock Co.
2. ________________________________
3. ________________________________
4. ________________________________

Topographic Considerations:
Approximate Capacity 22.1 Acre Feet
Approximate Dam Height 20'
Approximate Dam Length 154'

Existing Wetlands:
Appears to be some along channel area

Wetland Enhancement Potential:
Along reservoir tail water and fringes

Wildlife/Fishery Potential:
Poor - Not sufficient depth

Attached Information:
☐ Location Map ☐ Photographic Documentation
☐ Topographic Sketch ☐ Survey Data
☐ Other ________________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Bridger Pass 32

Date of Inventory: July 25, 1997

Reservoir Location (1/4, Section, Township, Range): NENE Section 32, T19N, R89W

Drainage Name: Separation Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Probably spring fed (quad shows springs at headwater)

Terrain (flat, rolling, etc.): Rolling (wide valley with steep side hills and ridges on both sides)
Range description: Grass in flood plain and on upper parts of ridges with sage on the side slopes

Range Condition: Good to fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1. 
2. 
3. 

Springs: None identified

Photo Log:

Film No. 2

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drainage area upstream</td>
</tr>
<tr>
<td>2</td>
<td>Drainage area downstream</td>
</tr>
<tr>
<td>3</td>
<td>Channel at proposed dike crossing</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track from County Road 605 up Jep Canyon to the reservoir site. The two track is approximately 20 miles from Rawlins on County Road 605. Two track crosses public and private lands.

Location: The drainage area is narrow in the location of the proposed reservoir. The side slopes are steep on both sides of the valley. The emergency spillway is proposed to be excavated out of the south side slope.

There appears to be some wetlands along the channel which is well defined and was flowing at the time of the inventory. There are also some willows at the proposed dike crossing with what appeared to be a beaver pond about 200 yards downstream.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

6,200’ X 5,000’ = 712 acres

Service Area Capacity

712 acres / 4 acres per AUM = 178 AUMs

Assumptions for Service Area:

• New Bridger Pass 6 down stream
• Steep hills on the north and south sides of the reservoir
• Service area ½ mile around reservoir
<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: 10 Brown Hill</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stream: Tributary to Coal Gulch</td>
</tr>
<tr>
<td></td>
<td>Contributing Drainage Area: .2 Sq. Mi.</td>
</tr>
<tr>
<td></td>
<td>Reservoir Service Area: 350 Acres</td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**

- Borrow Source: 
- Foundation: 

**Accessibility (Location & Description):**

- Two track off of County Road 603 which crosses private property.

**Potential Project Beneficiaries:**

1. Cobb Cattle
2. Cobb, John T
3. 
4. 

**Topographic Considerations:**

- Approximate Capacity: 1 Acre Ft.
- Approximate Dam Height: 18'
- Approximate Dam Length: 80'

**Existing Wetlands:**

- Does not appear to be any

**Wetland Enhancement Potential:**

- Poor

**Wildlife/Fishery Potential:**

- Poor

**Attached Information:**

- Location Map
- Photographic Documentation
- Topographic Sketch
- Survey Data
- Other
RESERVOIR INFORMATION FORM

Reservoir Description: Browns Hill 10

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): SENW Section 10, T14N, R89W

Drainage Name: Unknown

Stream Type (ephemeral, intermittent, etc.): appears to be intermittent

Source (Runoff, Springs, etc.): appears to be runoff

Terrain (flat, rolling, etc.): Rolling - flat plateau with deep valleys

Range description: grass with some sage

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1. 
2. 
3. 

Springs: None identified

Photo Log:

Film No. 4

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>15</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>16</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Browns Hill 10
RESERVOIR INFORMATION FORM

Access: A two track which crosses private property from Browns Hill road to the proposed site. The two track crosses a small dike and goes through a pasture along the top of Coal Gulch.

Location: The proposed reservoir is located at the top of the tributary drainage to Coal Gulch. The source of water for the drainage is runoff from the pasture area. The longitudinal slope as well as the side slopes are very steep. The reservoir will be small and the emergency spillway will need to be excavated out of the East side of the drainage.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[ 6,000' \times 2,500' + 2,500 \times 1,000 = 350 \text{ acres} \]

Service Area Capacity

350 acres / 4 acres per AUM = 88 AUMs

Assumptions for Service Area:

- Spring approximately ½ mile west
- Steep ridges on north side of drainage
- Service area extends approximately 1/4 mile west, along the ridge to the north, ½ mile south and 1 mile to the east.
**LITTLE SNAKE RIVER**  
**WATER DEVELOPMENT PROJECT - LEVEL II**  
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name:</th>
<th>Browns Hill 21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>Stream:</td>
<td>Loco Creek</td>
</tr>
<tr>
<td>21</td>
<td>Contributing Drainage Area:</td>
<td>1.4 Sq. Mi.</td>
</tr>
<tr>
<td>Township</td>
<td>Reservoir Service Area:</td>
<td>729 Acres</td>
</tr>
<tr>
<td>14</td>
<td>Ownership:</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>X Federal</td>
<td></td>
</tr>
<tr>
<td>89</td>
<td>□ State</td>
<td></td>
</tr>
<tr>
<td></td>
<td>□ Private</td>
<td></td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**

<table>
<thead>
<tr>
<th>Borrow Source:</th>
<th>Foundation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Accessibility (Location & Description):**

<table>
<thead>
<tr>
<th>Two track from County Road 602 that crosses private property</th>
</tr>
</thead>
</table>

**Potential Project Beneficiaries:**

1. Morgan, Sam  
2.  
3.  
4.  

**Topographic Considerations:**

<table>
<thead>
<tr>
<th>Approximate Capacity</th>
<th>17 Acre Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Dam Height</td>
<td>20</td>
</tr>
<tr>
<td>Approximate Dam Length</td>
<td>200</td>
</tr>
</tbody>
</table>

**Existing Wetlands:**

| Appears to be some along the low flow channel |

**Wetland Enhancement Potential:**

| Low |

**Wildlife/Fishery Potential:**

| Fair if supply is sufficient |

**Attached Information:**

<table>
<thead>
<tr>
<th>□ Location Map</th>
<th>□ Photographic Documentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Topographic Sketch</td>
<td>□ Survey Data</td>
</tr>
<tr>
<td>□ Other</td>
<td></td>
</tr>
</tbody>
</table>
Reservoir Description: Browns Hill 21

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 21, T14N, R89W

Drainage Name: Loco Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): probably springs and runoff

Terrain (flat, rolling, etc.): Hilly (Steep hills with deep valleys)

Range description: Recently burned - some sage with the grass

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: None identified

Photo Log:

<table>
<thead>
<tr>
<th>Film No. 4</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photo No.</td>
<td>Description</td>
</tr>
<tr>
<td>11</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>12</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>13</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Browns Hill 21
RESERVOIR INFORMATION FORM

Access:  A two track which crosses private property from browns hill road to the top of the drainage for Loco Creek. From the two track to the site in the drainage access is on foot.

Location:  The proposed site is in a deep draw with steep side slopes. The dike could be set at any height desired. The emergency spillway is proposed to be excavated out of the east side slope.

There was flow in Loco Creek at the time of the inventory and it appeared that some wetlands exists along the channel of the creek.

Reservoir Service Area:  The dimensions used for the service area are scaled from drawings used to show the service area.

5,500' X 5,500' + 3,000 X 500 = 729 acres

Assumptions for Service Area:

- No contributing sources of water
- Service area approximately ½ mile around reservoir except the service area was extended to 1 mile down the drainage.
# Little Snake River Water Development Project - Level II

## Project Inventory Form

### Location:
- **Reservoir Name:** Browns Hill 27
- **Stream:** Bird Gulch
- **Contributing Drainage Area:** 20.5 Sq. Mi.
- **Reservoir Service Area:** 350 Acres

<table>
<thead>
<tr>
<th>Section</th>
<th>27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Township</td>
<td>15</td>
</tr>
<tr>
<td>Range</td>
<td>89</td>
</tr>
</tbody>
</table>

### Description of Soil Suitability:
- **Borrow Source:**
  - Federal
  - State
  - Private

### Ownership:
- X Federal
- ☐ State
- ☐ Private

### Accessibility (Location & Description):
- Two track off of County Road 602 across private lands.

### Potential Project Beneficiaries:
1. Stratton Sheep
2. Snake River Land Co.
3. 
4. 

### Topographic Considerations:
- **Approximate Capacity:** 38 Acre Ft.
- **Approximate Dam Height:** 20
- **Approximate Dam Length:** 200

### Existing Wetlands:
- Appears to some along low flow channel

### Wetland Enhancement Potential:
- Possibly some along reservoir tail water and fringes

### Wildlife/Fishery Potential:
- Good if supply is sufficient

### Attached Information:
- ☐ Location Map
- ☐ Photographic Documentation
- ☐ Topographic Sketch
- ☐ Survey Data
- ☐ Other
RESERVOIR INFORMATION FORM

Reservoir Description: Browns Hill 27

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): SWSW Section 27, T15N, R89W

Drainage Name: Bird Gulch

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): probably springs

Terrain (flat, rolling, etc.): Hilly (Steep hills with deep valleys)

Range description: Grass in valley and flood plain areas, other areas primarily sage.

Range Condition: fair

Description of Contributing Water Sources For Range Management: Springs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1. 
2. 
3. 

Springs: Quad shows springs approximately 1/4 mile up Bird Gulch

Photo Log:

Film No. 4

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>18</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>19</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access:  A two track from Browns Hill Road (County Rd. 602) to top of ridge and north of the proposed site. Access from the ridge to the site is on foot. The two track crosses private property.

Location:  The side slopes of the drainage are steep with a plateau on the north side. The proposed site would have the emergency spillway discharge to a tributary drainage on the south side of the drainage. If a larger reservoir is desired the dike can be moved downstream to facilitate a higher dike. The location chosen for the proposed reservoir may have limitations to the dike height due to topography.

The drainage had flow at the time of the inventory and it appeared that wetlands exists along the channel.

Reservoir Service Area:  The dimensions used for the service area are scaled from drawings used to show the service area.

\[ 5,500' \times 6,500' + 2,500 \times 7,000 + 2,000 \times 1,000 = 906 \text{ acres} \]

Assumptions for Service Area:

- No contributing water sources
- Steep ridges on north and south sides of the drainage
- Service area approximately \( \frac{1}{2} \) mile around reservoir except the service area was extended to 1 mile up and down the drainage.
**LITTLE SNAKE RIVER**  
**WATER DEVELOPMENT PROJECT - LEVEL II**  
**PROJECT INVENTORY FORM**  

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Cottonwood Rim 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 10</td>
<td>Stream: Spring Creek</td>
</tr>
<tr>
<td>Township 12</td>
<td>Contributing Drainage Area: 3.0 Sq. Mi.</td>
</tr>
<tr>
<td>Range 87</td>
<td>Reservoir Service Area: 600 Acres</td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**  
Borrow Source:  
Foundation:  

**Accessibility (Location & Description):**  
Two track off of County Road 770 across private land.  

**Ownership:**  
- □ Federal  
- □ State  
- X Private  

**Potential Project Beneficiaries:**  
1. Marsh, Frank & Carroll Marie  
2.  
3.  
4.  

**Topographic Considerations:**  
- Approximate Capacity: 10 Acre Ft.  
- Approximate Dam Height: 15'  
- Approximate Dam Length: 200'  

**Existing Wetlands:**  
Appears to be some along drainage channel  

**Wetland Enhancement Potential:**  
Some along reservoir tail water and fringes  

**Wildlife/Fishery Potential:**  
Poor  

**Attached Information:**  
- □ Location Map  
- □ Photographic Documentation  
- □ Topographic Sketch  
- □ Survey Data  
- □ Other ___________________________
Reservoir Description: Cottonwood Rim 10

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): NWSE Section 10, T12N, R87W

Drainage Name: Spring Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): probably spring and runoff

Terrain (flat, rolling, etc.): Area of reservoir is flat with some rolling hills to the north

Range description: Primarily grass with some sage

Range Condition: good

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: None identified

Photo Log:

Film No. 5

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>17</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>18</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Cottonwood Rim 10
RESERVOIR INFORMATION FORM

Access: Along County Road 770 to Focus Ranch. North on private road through two locked gates and between an abandoned barn and house.

Location: Reservoir in relatively flat area approximately 100 yards upstream from existing buildings. The proposed site is just downstream of the intersection of three arteries of Spring Creek. The emergency spillway is proposed to be excavated out of the south knob. The drainage has a steep side slope on the north side and a flat area on the south side with only a small knob to tie into.

The site identified does not appear to be a very good site for a reservoir with the flat terrain. The reservoir would be shallow and not provide much storage or would not create a lot of wetlands.

After completing the inventory and leaving the site the property owner indicated that a better location for a reservoir is north of the proposed site on Forest Service land. He indicated that such a reservoir could be constructed for fisheries.
**LITTLE SNAKE RIVER**
**WATER DEVELOPMENT PROJECT - LEVEL II**
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name:</th>
<th>Stream:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 17</td>
<td>Cottonwood Rim 17</td>
<td>Unknown</td>
</tr>
<tr>
<td>Township 12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Range 87</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**

<table>
<thead>
<tr>
<th>Borrow Source:</th>
<th>Foundation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Accessibility (Location & Description):**

Two track off of County Road 770 across private land.

```
<table>
<thead>
<tr>
<th>Potential Project Beneficiaries:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Medicine Bow Inc.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
</tbody>
</table>
```

**Topographic Considerations:**

- Approximate Capacity: 2 Acre Ft.
- Approximate Dam Height: 17'
- Approximate Dam Length: 60'

**Existing Wetlands:**

- Appears to be some along low flow channel

**Wetland Enhancement Potential:**

Poor

**Wildlife/Fishery Potential:**

Poor

**Attached Information:**

- Location Map
- Photographic Documentation
- Topographic Sketch
- Survey Data
- Other
RESERVOIR INFORMATION FORM

Reservoir Description: Cottonwood Rim 17

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): SWSW Section 17, T12N, R87W

Drainage Name: Unknown

Stream Type (ephemeral, intermittent, etc.): Unknown - some flow at time of inventory

Source (Runoff, Springs, etc.): probably spring and runoff

Terrain (flat, rolling, etc.): Hilly

Range description: Grass with sage in valley and side slopes are bare or almost bare

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1.
2.
3.

Springs: None identified

Photo Log:

Film No. 5

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>14</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>15</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Cottonwood Rim 17

WWDC Level II
Access: Private road from County Road 770 for approximately 150 yards.

Location: Drainage channel is steep with steep side slopes. The reservoir will be small but relatively deep. The emergency spillway is proposed to be excavated out of the west side slope.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

3,000' X 5,000' = 344 acres

Service Area Capacity

344 acres / 4 acres per AUM = 86 AUMs

Assumptions for Service Area:

- No contributing water sources
- Terrain in area of reservoir is rolling hills
- Service area is restricted on the south by the county road. The service area is approximately ½ mile around reservoir except to the south.
**LITTLE SNAKE RIVER**  
**WATER DEVELOPMENT PROJECT - LEVEL II**  
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Dixon 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>11</td>
</tr>
<tr>
<td>Township</td>
<td>13</td>
</tr>
<tr>
<td>Range</td>
<td>91</td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**  
- **Borrow Source:** ____________________________  
- **Foundation:** ____________________________

**Accessibility (Location & Description):**  
- **Two track off of BLM Road 3309 across public lands**

**Ownership:**  
- **X Federal**
- **☐ State**
- **☐ Private**

**Contributing Drainage Area:** 35.3 Sq. Mi.  
**Reservoir Service Area:** 873 Acres

**Reservoir Name:** Dixon 11  
**Stream:** Deep Creek

**Potential Project Beneficiaries:**
1. Webber, Matt
2. ____________________________
3. ____________________________
4. ____________________________

**Topographic Considerations:**  
- **Approximate Capacity:** 76 Acre Feet  
- **Approximate Dam Height:** 21'  
- **Approximate Dam Length:** 250'

**Existing Wetlands:**  
- **Possibly some along low flow channel**

**Wetland Enhancement Potential:**  
- **Possibly along changes**

**Wildlife/Fishery Potential:**  
- **Minimal**

**Attached Information:**  
- **☐ Location Map**  
- **☐ Photographic Documentation**  
- **☐ Topographic Sketch**  
- **☐ Survey Data**  
- **☐ Other ____________________________**
RESERVOIR INFORMATION FORM

Reservoir Description: Dixon 11

Date of Inventory: August 24, 1997

Reservoir Location (1/4, Section, Township, Range): SENW Section 11, T13N, R91W

Drainage Name: Deep Creek

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent

Source (Runoff, Springs, etc.): Probably runoff (channel was saturated but there was no flow)

Terrain (flat, rolling, etc.): (Rolling)

Range description: Little grass except in channel and some in the flood plain areas

Range Condition: fair to poor

Description of Contributing Water Sources for Range Management: Reservoir

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: BLM Reservoir
   1. BLM Reservoir approximately 1 mile North (S2, T13N, R91W)
   2. 
   3. 

Springs: Possibly along stream channel

Photo Log:

Film No. 1

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Upstream Basin</td>
</tr>
<tr>
<td>13</td>
<td>Downstream Basin</td>
</tr>
<tr>
<td>14</td>
<td>Stream Channel at Proposed Dike Crossing</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track off of deep creek rim from BLM road down into Deep Creek Drainage. Reservoir site approximately 1/3 mile down drainage from where road intersects the drainage channel. The two track crosses public lands.

Location: Potential to create some wetlands on the North side of the reservoir and along the tail water area. Drainage has moderate slope longitudinally. The existing channel was saturated at the time of the inventory however there was no flow.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[
\frac{1}{2}(4,500 \times 2,500) + 5,000 \times 4,000 + 2,000 \times 2,200 + 4,000 \times 2,000 = 873 \text{ acres}
\]

Assumptions for Service Area

• No contributing water sources
• Service area 1/2 mile around reservoir
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Dixon 15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 15</td>
<td>Stream: Hicox Draw</td>
</tr>
<tr>
<td>Township 13</td>
<td>Contributing Drainage Area: 0.9 Sq. Mi.</td>
</tr>
<tr>
<td>Range 91</td>
<td>Reservoir Service Area: 505 Acres</td>
</tr>
</tbody>
</table>

Description of Soil Suitability:

<table>
<thead>
<tr>
<th>Borrow Source:</th>
<th>Ownership:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ Federal</td>
</tr>
<tr>
<td></td>
<td>□ State</td>
</tr>
<tr>
<td></td>
<td>X Private</td>
</tr>
</tbody>
</table>

Accessibility (Location & Description):

Two track off of County Road 702 that crosses public and private lands.

Potential Project Beneficiaries:

1. Webber, Matt
2. 
3. 
4. 

Topographic Considerations:

<table>
<thead>
<tr>
<th>Approximate Capacity: 0.6 Acre Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Dam Height: 18'</td>
</tr>
<tr>
<td>Approximate Dam Length: 80'</td>
</tr>
</tbody>
</table>

Existing Wetlands:

Does not appear to be any

Wetland Enhancement Potential:

Poor

Wildlife/Fishery Potential:

Poor

Attached Information:

□ Location Map
□ Photographic Documentation
□ Topographic Sketch
□ Survey Data
□ Other ___________________________
Reservoir Description: Dixon 15

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): NWSE Section 15, T13N, R91W

Drainage Name: Hicox Draw

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent

Source (Runoff, Springs, etc.): probably runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Sage with some grass

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoir

Type of Contributing Stream (ephemeral, intermittent, etc.): Muddy Creek

Description of existing Reservoirs:
1. BLM Reservoir approximately 1 mile east (Section 14, T13N, R91W)
2. 
3. 

Springs: None identified

Photo Log:

<table>
<thead>
<tr>
<th>Film No. 4</th>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Dixon 15
RESERVOIR INFORMATION FORM

Access: Two track that extends about 1.5 miles from county road. Two track crosses reservoir and goes east to proposed reservoir site. Two track cross private and public lands.

Location: Drainage channel is narrow and steep. Reservoir will be small with the emergency spillway excavated out of the north bank. The drainage did not have any flow at the time of the inventory. Supply appears to be from runoff.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

4,000' X 5,500' = 505 acres

Service Area Capacity

505 acres / 4 acres per AUM = 126 AUMs

Assumptions for Service Area:

• BLM Reservoir east of proposed reservoir and Muddy Creek to the west
• Service area approximately ¼ the distance to Muddy Creek and ½ mile east and west of the drainage.
**LITTLE SNAKE RIVER**

**WATER DEVELOPMENT PROJECT - LEVEL II**

**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name:</th>
<th>Dixon 34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>Stream:</td>
<td>Cottonwood Creek</td>
</tr>
<tr>
<td>34</td>
<td>Contributing Drainage Area:</td>
<td>16.3 Sq. Mi</td>
</tr>
<tr>
<td>Township</td>
<td>Reservoir Service Area:</td>
<td>460 Acres</td>
</tr>
<tr>
<td>13</td>
<td>Ownership:</td>
<td></td>
</tr>
<tr>
<td>Range</td>
<td>□ Federal</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>□ State</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X Private</td>
<td></td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**

<table>
<thead>
<tr>
<th>Borrow Source:</th>
<th>Foundation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Accessibility (Location & Description):**

<table>
<thead>
<tr>
<th>Two track across private property from County Road 503.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Ownership:**

1. Ladder
2. 
3. 
4. 

**Potential Project Beneficiaries:**

- Minimal

**Topographic Considerations:**

<table>
<thead>
<tr>
<th>Topographic Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

**Existing Wetlands:**

<table>
<thead>
<tr>
<th>Wetland Enhancement Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
</tr>
</tbody>
</table>

**Wildlife/Fishery Potential:**

<table>
<thead>
<tr>
<th>Attached Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Location Map</td>
</tr>
<tr>
<td>□ Photographic Documentation</td>
</tr>
<tr>
<td>□ Topographic Sketch</td>
</tr>
<tr>
<td>□ Survey Data</td>
</tr>
<tr>
<td>□ Other</td>
</tr>
</tbody>
</table>
**Reservoir Description:** Dixon 34

**Date of Inventory:** July 28, 1997

**Reservoir Location (1/4, Section, Township, Range):** SWNE Section 34, T13N, R89W

---

**Drainage Name:** Cottonwood Creek

**Stream Type (ephemeral, intermittent, etc.):** Appears to be intermittent

**Source (Runoff, Springs, etc.):** Probably runoff

---

**Terrain (flat, rolling, etc.):** Rolling

**Range description:** Predominately sage with some grass

**Range Condition:** fair

---

**Description of Contributing Water Sources For Range Management:** Flowing well

**Type of Contributing Stream (ephemeral, intermittent, etc.):** None identified

**Description of existing Reservoirs:** None identified

1.  
2.  
3.  

**Springs:** Flowing well approx. 1 mile north of proposed reservoir (Section 27, T13N, R90W)

---

**Photo Log:**

**Film No. 3**

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>2</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>3</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

**Little Snake River - Dixon 34**
RESERVOIR INFORMATION FORM

Access: Two track across private property from County Road 503 for approximately 1/4 mile to the proposed site.

Location: Drainage has steep side slopes and a fairly steep longitudinal slope. No flow was present at the inventory. There does not appear to be any wetland at the site. Emergency spillway is to be excavated out of the west side slope to a small tributary of the drainage.

Assumptions for Service Area:

- No contributing water sources
- Terrain in area of reservoir is rolling hills
- Service area is restricted by land ownership to the south. The remaining service area is ½ mile around the reservoir
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Reservoir Name: Doty Mountain 5
Stream: Dry Cow Creek
Contributing Drainage Area: 22.1 Sq. Mi.
Reservoir Service Area: 716 Acres

Ownership:
X Federal
□ State
□ Private

Accessibility (Location & Description):
Two track off of County Road 608 to reservoir site.
Two track crosses public lands.

Potential Project Beneficiaries:
1. Weber Ranch Inc.
2. 
3. 
4. 

Topographic Considerations:
Approximate Capacity 40 Acre Feet
Approximate Dam Height 20'
Approximate Dam Length 210'

Existing Wetlands:
Appears to be some along low flow channel

Wetland Enhancement Potential:
Appears to be potential along tail water and east side of reservoir

Wildlife/Fishery Potential:
Poor

Attached Information:
□ Location Map
□ Photographic Documentation
□ Topographic Sketch
□ Survey Data
□ Other ____________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Doty Mountain 5

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): NENE Section 5, T16N, R91W

Drainage Name: Dry Cow Creek

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent (Channel saturated but did not appear to be flowing)

Source (Runoff, Springs, etc.): Probably runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Predominantly sage with little grass. Some grass in the flood plain of the drainage.

Range Condition: Fair - poor

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: BLM reservoirs approximately 1 mile southwest, southeast, and northwest of proposed location.

Springs: None identified

Photo Log:

Film No. 2

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>5</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>6</td>
<td>Channel at proposed dike crossing</td>
</tr>
</tbody>
</table>

Little Snake River - Doty Mountain 5  2  WWDC Level II
RESERVOIR INFORMATION FORM

Access: Two track off of County Road 608 North past flowing well then east to Dry Cow Creek and south along drainage to reservoir site. Two track crosses public lands.

Location: Proposed dike location is just downstream of the intersection of a tributary to Dry Cow Creek and Dry Cow Creek. Drainage has steep side slope on the west side and a moderate slope on the east side. The emergency spillway is proposed to be excavated out of the east side of the drainage.

There appears to be some wetlands in the channel and there is some erosion along the channel bottom.

It appears that some wetlands can be created along the east side on the reservoir and along the fringes and tail water.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

6,000' X 5,200' = 716 acres

Assumptions for Service Area:

- No contributing water sources
- Terrain is rolling in area of reservoir
- Service area ½ mile around reservoir
Location:
Section 3
Township 15
Range 90

Reservoir Name: Garden Gulch 3
Stream: Wild Cow Creek
Contributing Drainage Area: 7.6 Sq. Mi.
Reservoir Service Area: 924 Acres

Description of Soil Suitability:
Borrow Source: ____________________________
Foundation: ____________________________

Accessibility (Location & Description):
Access from two track off of County Road 503 and enter drainage from just west of Lone Butte. Two track crosses private and public lands.

Ownership:
☐ Federal
☐ State
☒ Private

Reservoir located on 40 acre tract of private surrounded by public lands

Potential Project Beneficiaries:
1. Montgomery Livestock
2. Webber, Matt
3. 
4. 
5. 

Topographic Considerations:
Approximate Capacity 14 Acre Ft.
Approximate Dam Height 17
Approximate Dam Length 300

Existing Wetlands:
Appears to be some along low flow channel

Wetland Enhancement Potential:
Some along tail water and reservoir fringes

Wildlife/Fishery Potential:
Poor

Attached Information:
☐ Location Map
☐ Photographic Documentation
☐ Topographic Sketch
☐ Survey Data
☐ Other ________________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Garden Gulch 3

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): SENE Section 3, T15N, R90W

Drainage Name: Wild Cow Creek

Stream Type (ephemeral, intermittent, etc.): Stream was not flowing at time of inventory

Source (Runoff, Springs, etc.): Appears to be springs and runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Grass in valley and remainder predominately sage with little grass

Range Condition: fair - good

Description of Contributing Water Sources For Range Management: Reservoir

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM reservoir approximately 1 mile NW (Section 34, T16N, R90W)
2.
3.

Springs: None identified

Photo Log:

<table>
<thead>
<tr>
<th>Film No. 4</th>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track SW off of Ketchum Buttes road (County Rd. 503) around the south side of Lone Butte past an old well site to a two track which intersects from the NE. This road crosses both public and private property. The two tract to the NE drops into the Wild Cow drainage and crosses public land. After entering the Wild Cow drainage take the two track to the north up Wild Cow drainage.

Location: Proposed site is in a wide part of the drainage with a steep side slope on the south side and a gradual slope on the north side. Any increase in the height of the dam will significantly increase the length of the dike. This site would create some wetlands along the north side of the reservoir and along the tail water if supply is sufficient.

The drainage did not have any flow at this location at the time of the inventory. It does appear that some wetlands do exist in the channel area.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

2,500' X 1,500' + 6,500 X 5,000 + 2,000 X 2,000 = 924 acres

Assumptions for Service Area:

- No contributing water sources
- Service area approximately ½ mile around reservoir except the service area was extended to 1 mile up and down the drainage
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:
Section 32
Township 16
Range 90

Reservoir Name: Garden Gulch 32
Stream: Deep Gulch
Contributing Drainage Area: 16.2 Sq. Mi.
Reservoir Service Area: 929 Acres

Description of Soil Suitability:
Borrow Source: ____________________________
________________________________________
Foundation: ______________________________
________________________________________

Ownership:
X Federal
☐ State
☐ Private

Accessibility (Location & Description):
Two track up Deep Gulch from BLM Road 3308
________________________________________
________________________________________
________________________________________

Potential Project Beneficiaries:
1. Snake River Land Co.
   ______________________________________

Topographic Considerations:
Approximate Capacity 350 Acre Ft.
Approximate Dam Height 37'
Approximate Dam Length 400'

Existing Wetlands:
Appears to be along channel bottom

Vetland Enhancement Potential:
Possibly along reservoir fringes

Wildlife/Fishery Potential:
Good if source is sufficient

Attached Information:
☐ Location Map
☐ Photographic Documentation
☐ Topographic Sketch
☐ Survey Data
☐ Other ____________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Garden Gulch 32

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): SWSE Section 32, T16N, R90W

Drainage Name: Deep Gulch

Stream Type (ephemeral, intermittent, etc.): Flowing at the time of the inventory

Source (Runoff, Springs, etc.): Appears to be spring fed (quart shows spring on creek)

Terrain (flat, rolling, etc.): Rolling (Steep side slopes with wide valley)

Range description: Primarily grass in the valley (burned recently) and sage on the side slopes

Range Condition: good

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1.  

Springs: None identified

Photo Log:

Film No. 2

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<tr>
<th>Photo No.</th>
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<tbody>
<tr>
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<tr>
<td>11</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>12</td>
<td>Channel at proposed dike crossing</td>
</tr>
</tbody>
</table>

Little Snake River - Garden Gulch 32 2 WWDC Level II
RESERVOIR INFORMATION FORM

Access: Two track up Deep Gulch from BLM Road 3308. Two track crosses public lands.

Location: The proposed reservoir site is located in a deep drainage with a wide valley. The south side of the drainage has a steep side slope and the north side of the valley has a moderate slope up to the steep ridge. The emergency spillway is proposed to be excavated out of the moderate slope along the North side of the valley.

The drainage was flowing at the time of the inventory and it appears that wetlands exist in the bottom of the channel.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[ 5,300' \times 6,500' + (3,000 \times 1,000)^2 = 929 \text{ acres} \]

Assumptions for Service Area:

- No contributing water sources
- Steep hills on the north and south sides of the reservoir
- Service area \( \frac{1}{2} \) mile on north and south side of reservoir and 1 mile up and down the drainage.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:
Section 1
Township 15
Range 90

Reservoir Name: Ketchum Buttes 1
Stream: Wild Cow Creek
Contributing Drainage Area: 2.5
Reservoir Service Area: 758

Description of Soil Suitability:
Borrow Source: _______________________
Foundation: _________________________

Ownership:
X Federal
☐ State
☐ Private

Accessibility (Location & Description):
Two track off of County Road 503 and enter drainage from just west of Lone Butte. Road crosses both public and private lands.

Potential Project Beneficiaries:
1. Montgomery Livestock
2. Webber, Matt
3. _______________________
4. _______________________

Topographic Considerations:
Approximate Capacity 9 Acre Ft.
Approximate Dam Height 16'
Approximate Dam Length 150'

Existing Wetlands:
Appears to be some along low flow channel

Wetland Enhancement Potential: Minimal

Wildlife/Fishery Potential: Minimal

Attached Information:
□ Location Map  □ Photographic Documentation
□ Topographic Sketch  □ Survey Data
□ Other _______________________

Wildlife/Fishery Potential: Minimal
RESERVOIR INFORMATION FORM

Reservoir Description: Ketchum Buttes 1

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): SENE Section 1, T15N, R90W

Drainage Name: Wild Cow Creek

Stream Type (ephemeral, intermittent, etc.): Stream flowing at time of inventory

Source (Runoff, Springs, etc.): probably spring fed

Terrain (flat, rolling, etc.): Rolling

Range description: Grass in channel bottom and remainder predominately sage with little grass

Range Condition: fair

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM reservoir approximately 1/2 mile east (Section 6, T15, R89W)
2. Newly constructed reservoir approximately 1 mile SW (Section 2, T15N, R90W)
3. Springs: None identified

Photo Log:

Film No. 3

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<tr>
<th>Photo No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>23</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>24</td>
<td>Channel at proposed dike</td>
</tr>
<tr>
<td>4-1</td>
<td>Downstream drainage area</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track SW off of Ketchum Buttes road (County Rd. 503) around the south side of Lone Butte past an old well site to a two track which intersects from the NE. This road crosses both public and private property. The two tract to the NE drops into the Wild Cow drainage and crosses public land. After entering the Wild Cow drainage take the two track to the east up the middle fork.

Location: The proposed site has a steep side slope on the south side of the drainage and a moderate slope on the north side. The emergency spillway is proposed to be excavated out of the north side slope. The drainage had flow and some wetlands may exist along the channel.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

6,000' X 5,500' = 758 acres

Assumptions for Service Area:

- Newly constructed reservoir approximately 1 mile southwest
- Steep ridges on north and south side of drainage
- Service area approximately ½ mile around reservoir
**LOCATION:**

<table>
<thead>
<tr>
<th>Section</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Township</td>
<td>15</td>
</tr>
<tr>
<td>Range</td>
<td>89</td>
</tr>
</tbody>
</table>

**Reservoir Name:** Ketchum Buttes 3

**Stream:** Tributary of Little Savery

**Contribution Drainage Area:** 3.0 Sq. Mi.

**Reservoir Service Area:** 516 Acres

**Description of Soil Suitability:**

- **Borrow Source:**

- **Foundation:**

**Accessibility (Location & Description):**

- **Approximately 1/4 mile across private property from County Road 503**

**Ownership:**

- X Federal
- □ State
- □ Private

**Potential Project Beneficiaries:**

1. Their, Bruce
2. Wenger Ranches
3. 
4. 

**Topographic Considerations:**

- **Approximate Capacity:** 26 Acre Ft.
- **Approximate Dam Height:** 16
- **Approximate Dam Length:** 180

**Existing Wetlands:**

- **Possibly along low flow channel**

**Wetland Enhancement Potential:** Good

**Wildlife/Fishery Potential:** Poor

**Attached Information:**

- □ Location Map
- □ Photographic Documentation
- □ Topographic Sketch
- □ Survey Data
- □ Other __________________________
Reservoir Description: Ketchum Buttes 3

Date of Inventory: July 29, 1997

Reservoir Location (1/4, Section, Township, Range): NWSW Section 3, T15N, R89W

Drainage Name: Tributary of Savery Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Possibly spring fed

Terrain (flat, rolling, etc.): Rolling

Range description: Grass along channel and some on side slopes. Other areas sage.

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1. 
2. 
3. 

Springs: None identified

Photo Log:

Film No. 3

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
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<tr>
<td>13</td>
<td>Upstream drainage area of west tributary</td>
</tr>
<tr>
<td>14</td>
<td>Upstream drainage area of north tributary</td>
</tr>
<tr>
<td>15</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>16</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Ketchum Buttes 3 2
RESERVOIR INFORMATION FORM

Access: Walk approximately 1/4 mile across private property to proposed reservoir site from Ketchum Buttes Road.

Location: Proposed reservoir site just downstream of intersection of two tributaries. Drainage has a steep side slope on the south side with a more moderate slope on the north side. The drainage has some flow and it appeared that there are some wetlands along the channel.

The reservoir could create some wetlands along the north side, fringes and tail water areas.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

5,000' X 4,500' = 516 acres

Assumptions for Service Area:

- BLM Reservoir 1 mile west Ketchum Buttes 34 1 mile north and Little Savery 1 mile east
- Terrain in area of reservoir is gentle rolling hills
- Service area approximately ½ mile around reservoir
### LITTLE SNAKE RIVER
### WATER DEVELOPMENT PROJECT - LEVEL II
### PROJECT INVENTORY FORM

**Location:**
- Section: 25
- Township: 16
- Range: 90

**Reservoir Name:** Ketchum Buttes 25
**Stream:** Wild Cow Creek
**Contributing Drainage Area:** 2.7 Sq. Mi.
**Reservoir Service Area:** 916 Acres

**Description of Soil Suitability:**
- Borrow Source: ____________________________
- Foundation: ______________________________

**Accessibility (Location & Description):**
- Two track off of County Road 503 and enter drainage from just west of Lone Butte. Two track crosses private and public lands

**Ownership:**
- X Federal
- □ State
- □ Private

**Potential Project Beneficiaries:**
1. Montgomery Livestock
2. Desert Cattle Co.
3. Stratton Sheep Co.
4. ________________________________

**Topographic Considerations:**
- Approximate Capacity: 81 Acre Ft.
- Approximate Dam Height: 23
- Approximate Dam Length: 250

**Existing Wetlands:**
- Appears to be wetlands in bottom of drainage

**Wetland Enhancement Potential:**
- Possibly some along reservoir tail water area

**Wildlife/Fishery Potential:**
- Appears to be good if supply is sufficient

**Attached Information:**
- □ Location Map
- □ Photographic Documentation
- □ Topographic Sketch
- □ Survey Data
- □ Other ____________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Ketchum Buttes 25

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 25, T16N, R90W

Drainage Name: Wild Cow Creek

Stream Type (ephemeral, intermittent, etc.): Stream flowing at time of inventory

Source (Runoff, Springs, etc.): probably spring fed

Terrain(flat, rolling, etc.): Rolling (Steep side slopes with wide valley)

Range description: Grass in valley and remainder predominately sage with little grass

Range Condition: fair - good

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
  1.
  2.
  3.

Springs: None identified

Photo Log:

Film No. 4

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<tr>
<td>3</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>4</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track SW off of Ketchum Buttes road (County Rd. 503) around the south side of Lone Butte past an old well site to a two track which intersects from the NE. This road crosses both public and private property. The two tract to the NE drops into the Wild Cow drainage and crosses public land. After entering the Wild Cow drainage take the two track to the north up Wild Cow drainage.

Location: The proposed reservoir site is in a wide valley with steep side slopes. The existing valley where the tributary intersects the drainage is saturated from what appears to be springs. The area upstream from the proposed dike appears to have considerable wetlands.

The emergency spillway is proposed to be excavated out of the west side slope of the valley.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

2,500’ X 600’ + 4,800 X 8,000 = 916 acres

Assumptions for Service Area:

- No contributing water sources
- Steep ridges on north and south side of drainage
- Service area approximately 1/2 mile around reservoir except the service area was extended to 1 mile down stream.
# LITTLE SNAKE RIVER
## WATER DEVELOPMENT PROJECT - LEVEL II
### PROJECT INVENTORY FORM

<table>
<thead>
<tr>
<th>Location</th>
<th>Reservoir Name: Ketchum Buttes 34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>34</td>
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<tr>
<td>Township</td>
<td>16</td>
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<tr>
<td>Range</td>
<td>89</td>
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<tr>
<td>Stream:</td>
<td>Tributary to Little Savery Creek</td>
</tr>
<tr>
<td>Contributing Drainage Area:</td>
<td>3.7 Sq. Mi.</td>
</tr>
<tr>
<td>Reservoir Service Area:</td>
<td>573 Acres</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Description of Soil Suitability:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Borrow Source:</td>
</tr>
<tr>
<td>Foundation:</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessibility (Location &amp; Description):</th>
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<tbody>
<tr>
<td>Two track off of County Road 503 approximately 100 yards.</td>
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<table>
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<tr>
<th>Ownership:</th>
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<table>
<thead>
<tr>
<th>Potential Project Beneficiaries:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sandstone Ranches</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
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</table>

<table>
<thead>
<tr>
<th>Topographic Considerations:</th>
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</thead>
<tbody>
<tr>
<td>Approximate Capacity</td>
</tr>
<tr>
<td>Approximate Dam Height</td>
</tr>
<tr>
<td>Approximate Dam Length</td>
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<table>
<thead>
<tr>
<th>Existing Wetlands:</th>
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<tbody>
<tr>
<td>Description, Acreage</td>
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</table>

<table>
<thead>
<tr>
<th>Wetland Enhancement Potential:</th>
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</thead>
<tbody>
<tr>
<td>Fair along reservoir fringes and tail water</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Wildlife/Fishery Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poor</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Attached Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location Map</td>
</tr>
<tr>
<td>Photographic Documentation</td>
</tr>
<tr>
<td>Topographic Sketch</td>
</tr>
<tr>
<td>Survey Data</td>
</tr>
<tr>
<td>Other</td>
</tr>
</tbody>
</table>
Reservoir Description: Ketchum Buttes 34

Date of Inventory: July 29, 1997

Reservoir Location (1/4, Section, Township, Range): NESW Section 34, T16N, R89W

Drainage Name: Tributary to Savery Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): possibly springs

Terrain (flat, rolling, etc.): Rolling

Range description: Grass in valley areas and primarily sage on hills with some grass.

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM reservoir approximately 1 mile NE (Section 27, T16N, R89W)
2. BLM reservoir approximately 1 mile west (Section 33, T15N, R89W)
3. Springs: None identified

Photo Log:

Film No. 3

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<th>Photo No.</th>
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<tbody>
<tr>
<td>17</td>
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</tr>
<tr>
<td>18</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>19</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track along drainage approximately 200 yards upstream from Ketchum Buttes Road (County Rd. 503).

Location: The proposed reservoir site was moved to a location upstream which was more suitable for constructing a reservoir. The drainage is fairly small with some flow and it appears that some wetlands exist along the flood plain area of the channel. The emergency spillway is proposed to be excavated out of the west side slope and possibly discharge into a small tributary of the drainage.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

5,000' X 5,000' = 573 acres

Assumptions for Service Area:

- BLM Reservoir 1 mile west and southwest, Ketchum Buttes 3 1 mile southeast and Little Savery east
- Terrain in the area of the reservoir is gentle rolling hills
- Service area approximately ½ mile around reservoir
Location: Section 8  Township 16  Range 88

Reservoir Name: McCarty Ranch 8  Stream: McCarty Creek  Contributing Drainage Area: 1.5 Sq. Mi.  Reservoir Service Area: 666 Acres

Description of Soil Suitability:
Borrow Source:____________________________

Foundation:____________________________

Ownership:

☐ Federal
☒ State
☐ Private

Accessibility (Location & Description):
Reservoir adjacent to County Road 503

Potential Project Beneficiaries:
1. Stratton, Don

Approximate Capacity 8 Acre Ft.
Approximate Dam Height 17'
Approximate Dam Length 120'

Existing Wetlands: Possibly along low flow channel

Wetland Enhancement Potential: Some along reservoir fringes

Wildlife/Fishery Potential: Some if sufficient depth can be maintained

Topographic Considerations:

Attached Information: ☐ Location Map  ☐ Photographic Documentation
☐ Topographic Sketch  ☐ Survey Data
☐ Other __________________________
Reservoir Description: McCarty Ranch 8

Date of Inventory: July 29, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 8, T16N, R88W

Drainage Name: McCarty Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): probably spring fed

Terrain (flat, rolling, etc.): Rolling

Range description: Primarily grass with some sage

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: None identified

Photo Log:

<table>
<thead>
<tr>
<th>Film No.</th>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>10</td>
<td>Upstream drainage area</td>
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<tr>
<td></td>
<td>11</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - McCarty Ranch 8 2 WWDC Level II
RESERVOIR INFORMATION FORM

Access: Reservoir is adjacent to County Road 503 (McCarty Ranch Rd)

Location: Reservoir limited because of location of county road. Drainage flowing at time of inventory. Possibly wetlands along channel. Emergency spillway to be excavated out of the North side slope next to the County Rd.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

5,000' X 5,500' + 1,500 X 1,000 = 666 acres

Assumptions for Service Area:

- No contributing water sources
- Steep ridges on the sides of the drainage
- Service area approximately ½ mile around reservoir except the service area was extended to 3/4 mile up the drainage.
**LITTLE SNAKE RIVER**  
**WATER DEVELOPMENT PROJECT - LEVEL II**  
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
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<td>Township</td>
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<tr>
<td>Range</td>
<td>91</td>
<td></td>
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</tr>
</tbody>
</table>

**Reservoir Name:** Peach Orchard Flat 6  
**Stream:** Cottonwood Creek  
**Contributing Drainage Area:** 21.7 Sq. Mi.  
**Reservoir Service Area:** 947 Acres

**Ownership:**  
- [x] Federal  
- [ ] State  
- [ ] Private

**Accessibility (Location & Description):**  
Access from Highway 789 across public lands

**Potential Project Beneficiaries:**  
1. Chant, James L. Jr.
2.  
3.  
4.  

**Topographic Considerations:**  
- Approximate Capacity: 36.9 Acre Feet  
- Approximate Dam Height: 22'  
- Approximate Dam Length: 329'

**Existing Wetlands:**  
- Does not appear to be any

**Wetland Enhancement Potential:** Minimal

**Wildlife/Fishery Potential:** Poor

**Attached Information:**  
- [ ] Location Map  
- [ ] Photographic Documentation  
- [ ] Topographic Sketch  
- [ ] Survey Data  
- [ ] Other ___________________
RESERVOIR INFORMATION FORM

Reservoir Description: Peach Orchard Flat 6

Date of Inventory: August 24, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 6, T13N, R91W

Drainage Name: Cottonwood Creek

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent

Source (Runoff, Springs, etc.): Probably runoff from drainage area

Terrain (flat, rolling, etc.): Rolling (Flat drainage with steep side hills)

Range description: Predominately sagebrush

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None

Description of existing Reservoirs: 2 BLM Reservoirs
  1. BLM Reservoirs Approx. 1 1/2 mile up Cottonwood Creek (S1, T13N, R92W)
  2. BLM Reservoirs Approx. 1 mile up Strecktus Draw (S12, T12N, R92W)

Springs: N/A

Photo Log:

Film No. 1

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 - 11</td>
<td>Unknown</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Access: Two track across public land from highway 789 to the reservoir site.

Location: The proposed project will repair an existing dike which has washed out. The existing dike appears to have washed out through the original spillway. The washed out section is on the North side of the drainage. The washed out section is eroded an area approximately 80 feet wide and about 20 feet deep. The new structure will have a spillway constructed on the North side of the drainage and tied into the existing eroded section down stream of the dike. The new spillway will tie in at a location which will not be conducive to additional erosion and a principal spillway should be installed to reduce the potential for future failure.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

\[
3,000' \times 2,500' + 7,500 \times 4,500 = 947 \text{ acres}
\]

Assumptions for Service Area:

- BLM Reservoir 1 mile SE restricts service are on the west
- Steep hills on the north and west sides of the reservoir
- Service area ½ mile around reservoir except to the east down the drainage which was extended to a mile.
**Location:**
- **Section:** 34
- **Township:** 15
- **Range:** 91

**Reservoir Name:** Peach Orchard Flat 34

**Stream:** Cherokee Creek

**Contributing Drainage Area:** 30 Sq. Mi.

**Reservoir Service Area:** 918 Acres

**Description of Soil Suitability:**

**Borrow Source:**

**Foundation:**

**Accessibility (Location & Description):**
- Two track off of BLM Road 3309 across public lands

**Ownership:**
- X Federal
- ☐ State
- ☐ Private

**Potential Project Beneficiaries:**

1. Montgomery Livestock
2. Snake River Land Co.
3. 
4. 

**Topographic Considerations:**
- **Approximate Capacity:** 1189 Acre Ft
- **Approximate Dam Height:** 30' 
- **Approximate Dam Length:** 1298'

**Existing Wetlands:**
- Possibly along low flow channel

**Wetland Enhancement Potential:**
- Some along east side of reservoir and tail water

**Wildlife/Fishery Potential:**
- Poor

**Attached Information:**
- Location Map
- Photographic Documentation
- Topographic Sketch
- Survey Data
- Other
RESERVOIR INFORMATION FORM

Reservoir Description: Peach Orchard Flat 34

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): NWSW Section 34, T15N, R91W

Drainage Name: Cherokee Creek

Stream Type (ephemeral, intermittent, etc.): Unknown (Dry at time of inventory)

Source (Runoff, Springs, etc.): Probably runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Some grass with sage

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoir

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM reservoir approximately ½ mile Northwest (Section 33, T15N, R91W)
2. 
3. 

Springs: None identified

Photo Log:

Film No. 2

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>17</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>18</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Peach Orchard Flat 34
RESERVOIR INFORMATION FORM

Access: Two track off of BLM Road 3309 and then by a series of seismic trails and cross country travel Southeast from the two track to the reservoir site. Two track crosses public lands.

Location: The drainage is fairly steep on the west side with a moderate slope on the east side. The drainage has a fairly flat longitudinal slope. The emergency spillway is proposed to be excavated out of the moderate slope on the east side of the drainage. There is some potential to create wetlands along the east side, tail water and fringes of the reservoir.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

\[
3,500' \times 3,000' + 5,000 \times 5,000 + 3,000 \times 1,500 = 918 \text{ acres}
\]

Service Area Capacity

918 acres / 4 acres per AUM = 230 AUMs

Assumptions for Service Area:

- No contributing water sources
- Service area approximately ½ mile north and south of the drainage and approximately 3/4 mile up and down the drainage.
LITTLE SNAKE RIVER  
WATER DEVELOPMENT PROJECT - LEVEL II  
PROJECT INVENTORY FORM

<table>
<thead>
<tr>
<th>Location:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
</tr>
<tr>
<td>Township 16</td>
</tr>
<tr>
<td>Range 87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reservoir Name:</th>
<th>Pine Grove Ranch 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stream:</td>
<td>Little Savory Creek</td>
</tr>
<tr>
<td>Contributing Drainage Area:</td>
<td>2.0 Sq. Mi.</td>
</tr>
<tr>
<td>Reservoir Service Area:</td>
<td>744 Acres</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ownership:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Federal</td>
</tr>
<tr>
<td>X State</td>
</tr>
<tr>
<td>□ Private</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessibility (Location &amp; Description):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two track off of County Road 503 just south of the McCarty Ranch.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Project Beneficiaries:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Stratton, Don</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Topographic Considerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Capacity 56 Acre Ft.</td>
</tr>
<tr>
<td>Approximate Dam Height 20</td>
</tr>
<tr>
<td>Approximate Dam Length 300</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Existing Wetlands:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appears to be some in low flow channel</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wetland Enhancement Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appears to be some along tail water area of reservoir</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wildlife/Fishery Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fair if source is adequate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attached Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Location Map</td>
</tr>
<tr>
<td>□ Photographic Documentation</td>
</tr>
<tr>
<td>□ Topographic Sketch</td>
</tr>
<tr>
<td>□ Survey Data</td>
</tr>
<tr>
<td>□ Other</td>
</tr>
</tbody>
</table>
RESERVOIR INFORMATION FORM

Reservoir Description: Pine Grove Ranch 1

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): NESE Section 1, T16N, R89W

Drainage Name: Little Savery Creek

Stream Type (ephemeral, intermittent, etc.): flowing at time of inventory

Source (Runoff, Springs, etc.): appears to be springs

Terrain (flat, rolling, etc.): Rolling (wide valleys with steep side slopes)

Range description: grass in the valley with sage and grass on the side hills

Range Condition: Good

Description of Contributing Water Sources For Range Management: Beaver ponds

Type of Contributing Stream (ephemeral, intermittent, etc.): Little Savery Creek

Description of existing Reservoirs: None identified

1.
2.
3.

Springs: None identified

Photo Log:

Film No. 4

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>9</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>10</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Pine Grove Ranch 1 2 WWDC Level II
RESERVOIR INFORMATION FORM

Access: Two track off of McCarty Ranch Road just southwest of the McCarty Ranch. The two track crosses both private and public lands. The two track goes west then circles a meadow and heads back to the NE.

Location: The proposed site is in a drainage with a wide bottom. The area upstream where the a tributary intersects the drainage could create some wetlands if the depth in the reservoir is properly set. The emergency spillway is proposed to be excavated out of the south slope of the drainage. The reservoir could be constructed at any depth.

The drainage had flow at the time of the inventory and it appeared that wetlands existed along the channel.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

1,200' X 2,000' + 5,000 X 6,000 = 744 acres

Assumptions for Service Area:

- Beaver ponds downstream approximately 1 mile
- Steep ridges on north and south sides of the drainage
- Service area approximately 2000 feet north and south and ½ mile up and down stream.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:
Section 22
Township 17
Range 89

Reservoir Name: Pole Gulch 22
Stream: __________________________
Contributing Drainage Area: 3.1 Sq. Mi.
Reservoir Service Area: 460 Acres

Description of Soil Suitability:
Borrow Source: __________________________
Foundation: __________________________

Ownership:
X Federal
☐ State
☐ Private

Accessibility (Location & Description):
Two track from BLM Road 3308 across public and private lands. Two track goes past Pole Gulch 27.

Potential Project Beneficiaries:
1. Stratton Sheep
2. __________________________
3. __________________________
4. __________________________

Topographic Considerations: Approximate Capacity 5 Acre Ft.
Approximate Dam Height 14'
Approximate Dam Length 180'

Existing Wetlands: Appears to be some along low flow channel
(Wetland Enhancement Potential: Possibly some along tail water and fringes of reservoir
Wildlife/Fishery Potential: Some potential

Attached Information:
☐ Location Map ☐ Photographic Documentation
☐ Topographic Sketch ☐ Survey Data
☐ Other __________________________
**RESERVOIR INFORMATION FORM**

Reservoir Description: Pole Gulch 22

Date of Inventory: July 29, 1997

Reservoir Location (1/4, Section, Township, Range): SWNW Section 22, T17N, R89W

Drainage Name: Tributary to Muddy Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Springs

Terrain (flat, rolling, etc.): Rolling

Range description: Primarily grass with some sage

Range Condition: Good

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1. 
2. 
3.

Springs: None identified

---

### Photo Log:

**Film No. 3**

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>5</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>6</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

---

Little Snake River - Pole Gulch 22
RESERVOIR INFORMATION FORM

Access: Two track across private and public lands. Two track goes past Pole Gulch 27 down into drainage from BLM Road 3308.

Location: Drainage area has moderate side slopes. The emergency spillway is proposed to be excavated out of the west side slope. The drainage had flow at the time of the inventory. Possibly wetlands in the channel of the drainage.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

5,000' X 4,000' = 459 acres

Assumptions for Service Area:

• BLM Reservoir ½ mile north, spring approximately 1 mile south
• Terrain in the area of the reservoir has rolling hills
• Service area approximately ½ mile around reservoir
**LITTLE SNAKE RIVER**
**WATER DEVELOPMENT PROJECT - LEVEL II**
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Pole Gulch 27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 27</td>
<td>Stream:</td>
</tr>
<tr>
<td>Township 17</td>
<td>Contributing Drainage Area: 0.9 Sq. Mi.</td>
</tr>
<tr>
<td>Range 89</td>
<td>Reservoir Service Area: 760 Acres</td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**

<table>
<thead>
<tr>
<th>Borrow Source:</th>
<th>Ownership:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>□ Federal</td>
</tr>
<tr>
<td></td>
<td>□ State</td>
</tr>
<tr>
<td></td>
<td>X Private</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Foundation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Accessibility (Location & Description):**

- Two track off of BLM Road 3308 across public and private property

**Potential Project Beneficiaries:**

1. Stratton Sheep
2. 
3. 
4. 

**Topographic Considerations:**

<table>
<thead>
<tr>
<th>Approximate Capacity</th>
<th>4 Acre Ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Dam Height</td>
<td>20'</td>
</tr>
<tr>
<td>Approximate Dam Length</td>
<td>150'</td>
</tr>
</tbody>
</table>

**Existing Wetlands:**

- Appears to be some along low flow channel

**Wetland Enhancement Potential:**

- Minimal

**Wildlife/Fishery Potential:**

- Some

**Attached Information:**

- □ Location Map
- □ Photographic Documentation
- □ Topographic Sketch
- □ Survey Data
- □ Other __________________________
Reservoir Description: Pole Gulch 27

Date of Inventory: July 29, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 27, T17N, R89W

Drainage Name: Tributary to Muddy Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Spring fed

Terrain (flat, rolling, etc.): Rolling - flat bluff with deep valleys

Range description: primarily grass with some sage

Range Condition: fair

Description of Contributing Water Sources: Spring

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: Spring approximately ½ mile southeast

Photo Log:

<table>
<thead>
<tr>
<th>Film No.</th>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>7</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Pole Gulch 27
RESERVOIR INFORMATION FORM

Access: Two track off of BLM Road 3308. Two track crosses private property to site. Only about ½ mile from BLM road to the reservoir site

Location: Drainage is small with steep side slopes. The reservoir will be small but it will be fed by a spring. The dike height and location needs to be set so that the hydraulics of the spring will not be affected. The emergency spillway is to be excavated out of the south side slope to a small gully which leads back to the drainage.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

7,000' X 4,500' = 723 acres

Assumptions for Service Area:

- Pole Gulch 22 reservoir to the northeast and a spring approximately 1 mile east
- Terrain in the area of the reservoir is rolling hills
- Service area approximately ½ mile around reservoir except the service area was extended to 1 mile on the west side.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:
Section 28
Township 20
Range 90

Reservoir Name: Riner 28
Stream: Separation Creek
Contributing Drainage Area: 60.5 Sq. Mi.
Reservoir Service Area: 777

Description of Soil Suitability:
Borrow Source:__________________________________________
Foundation:_________________________________________

Ownership:
X Federal
☐ State
☐ Private

Accessibility (Location & Description):
Two track off of Interstate 80 to the reservoir site.
Two track crosses public and private lands.

Potential Project Beneficiaries:
1. Wyoming Game and Fish
2. Chant, James L. Jr.
3. __________________________
4. __________________________

Topographic Considerations: Approximate Capacity 325 Acre Feet
Approximate Dam Height 20'
Approximate Dam Length 1070'

Existing Wetlands: Appears to be some along low flow channel

Wetland Enhancement Potential: Good

Wildlife/Fishery Potential: Poor

Attached Information: ☐ Location Map ☐ Photographic Documentation
☐ Topographic Sketch ☐ Survey Data
☐ Other __________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Riner 28

Date of Inventory: July 25, 1997

Reservoir Location (1/4, Section, Township, Range): NWSW Section 28, T20N, R90W

Drainage Name: Separation Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Unknown

Terrain (flat, rolling, etc.): Fairly flat

Range description: Primarily sage with some grass on top of ridges and in flood plain.

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:

1. BLM Reservoir or pit approximately ½ mile down Separation Creek (Section 28, T20N, R90W)

Springs: None identified

Photo Log:

Film No. 1

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>16</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>17</td>
<td>Channel at dike crossing</td>
</tr>
<tr>
<td>18</td>
<td>General range at dike area</td>
</tr>
</tbody>
</table>

Little Snake River - Riner 28
RESERVOIR INFORMATION FORM

Access: Reservoir is adjacent to two track from Interstate 80. Two track crosses both public and private property.

Location: Area is flat and reservoir would be shallow and would create some wetlands if the supply is sufficient. The emergency spillway is to be constructed along the west side of the reservoir.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

\[ 5,200' \times 4,000' + 4,200 \times 1,200 + 2,500 \times 3,200 = 777 \text{ acres} \]

Service Area Capacity

\[ 777 \text{ acres} / 4 \text{ acres per AUM} = 194 \text{ AUMs} \]

Assumptions for Service Area:

- BLM Pit 1/4 mile north
- Service area 1/2 mile around reservoir except to the south up the drainage which was extended to a mile.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:

Section 4
Township 12
Range 89

Description of Soil Suitability:

Borrow Source: ________________________________

Foundation: ________________________________

Accessibility (Location & Description):

Two track off of Highway 70 across public and private lands

Potential Project Beneficiaries:

1. Kaisler Brothers

2. 

3. 

4. 

Topographic Considerations:

Approximate Capacity 11 Acre Ft.
Approximate Dam Height 17'
Approximate Dam Length 200'

Existing Wetlands:

Appears to be some along drainage bottom

Wetland Enhancement Potential:

Fair along reservoir fringes and tail water

Wildlife/Fishery Potential:

Poor

Attached Information:

☐ Location Map ☐ Photographic Documentation

☐ Topographic Sketch ☐ Survey Data

☐ Other ________________________________
Reservoir Description: Savery 4

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 4, T12N, R89W

Drainage Name: Coal Bank Draw

Stream Type (ephemeral, intermittent, etc.): Unknown - No flow at inventory but water present in some areas of the flood plain.

Source (Runoff, Springs, etc.): probably springs and runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Recently burned and grass is being established

Range Condition: Fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1.
2.
3.

Springs: None identified

Photo Log:

Film No. 5

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>11</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>12</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Savery 4 2  WWDC Level II
RESERVOIR INFORMATION FORM

Access: Two track for approximately 2 miles from highway 70 to Coal Bank Draw. Take another two track to the west along the draw to the end of the two track. The proposed reservoir site is about 150 yards down the draw from the end of the two track.

Location: Drainage has a steep side slope along the west side with a relatively flat plateau on the east side. Reservoir depth is set such that the east side of plateau can be used for and emergency spillway. Plateau and tail water should create some wetlands if supply is sufficient.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

6,000' X 5,000' + 2,000 X 1,200 = 744 acres

Assumptions for Service Area:

• No contributing water sources
• Service area approximately ½ mile around reservoir except the service area was extended to 1 mile up the drainage.
**LITTLE SNAKE RIVER**
**WATER DEVELOPMENT PROJECT - LEVEL II**
**PROJECT INVENTORY FORM**

**Location:**
- Section: 8
- Township: 13
- Range: 89

**Description of Soil Suitability:**
- Borrow Source: _______________________
- Foundation: _________________________

**Accessibility (Location & Description):**
- Two track from County Road 501 across private property.

**Reservoir Name:** Savery 8
**Stream:** Negro Creek
**Contributing Drainage Area:** 0.7 Sq. Mi.
**Reservoir Service Area:** 344 Acres

**Ownership:**
- Federal
- State
- Private

**Potential Project Beneficiaries:**
1. McCalister, Donald
2. _______________________
3. _______________________
4. _______________________

**Topographic Considerations:**
- Approximate Capacity: 3 Acre Ft.
- Approximate Dam Height: 18'
- Approximate Dam Length: 120'

**Existing Wetlands:**
- Description, Acreage: ________________
- Does not appear to be any

**Wetland Enhancement Potential:**
- Poor

**Wildlife/Fishery Potential:**
- Poor

**Attached Information:**
- Location Map
- Photographic Documentation
- Topographic Sketch
- Survey Data
- Other
RESERVOIR INFORMATION FORM

Reservoir Description: Savery 8

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): NESE Section 8, T13N, R89W

Drainage Name: Negro Creek

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent

Source (Runoff, Springs, etc.): Appears to be runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Mostly sage with a little grass

Range Condition: fair - poor

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: None identified

Photo Log:

Film No. 4

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>5-1</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>5-2</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Savery 8
RESERVOIR INFORMATION FORM

Access: Two track road from County Road 501 across private land to the proposed site.

Location: The proposed site is in a relatively small drainage with steep side slopes. The drainage did not have any flow at the time of the inventory. Wetlands did not appear to be present at the proposed site. The emergency spillway will need to be excavated out of the west side slope.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

5,000' x 3,000' = 344 acres

Service Area Capacity

344 acres / 4 acres per AUM = 86 AUMs

Assumptions for Service Area:

- No contributing water sources
- Property line restriction on the east side of the drainage.
- Service area approximately ½ mile around reservoir except on the east side.
# LITTLE SNAKE RIVER
**WATER DEVELOPMENT PROJECT - LEVEL II**
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Savery 18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>18</td>
</tr>
<tr>
<td>Township</td>
<td>13</td>
</tr>
<tr>
<td>Range</td>
<td>89</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stream:</th>
<th>Dutch Joe Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contributing Drainage Area:</td>
<td>0.9 Sq. Mi.</td>
</tr>
<tr>
<td>Reservoir Service Area:</td>
<td>758 Acres</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ownership:</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Federal</td>
</tr>
<tr>
<td>☐ State</td>
</tr>
<tr>
<td>☒ Private</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Accessibility (Location &amp; Description):</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access from oil field roads south of the proposed site off of County Road 503.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Project Beneficiaries:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Cobb Cattle Co.</td>
</tr>
<tr>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Topographic Considerations:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approximate Capacity 39 Acre Ft.</td>
</tr>
<tr>
<td>Approximate Dam Height 20'</td>
</tr>
<tr>
<td>Approximate Dam Length 230'</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Existing Wetlands:</th>
</tr>
</thead>
<tbody>
<tr>
<td>The bottom of the channel area appears to be wetlands</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wetland Enhancement Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some along reservoir fringes and tail water</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wildlife/Fishery Potential:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some if supply is sufficient</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Attached Information:</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐ Location Map</td>
</tr>
<tr>
<td>☐ Photographic Documentation</td>
</tr>
<tr>
<td>☐ Topographic Sketch</td>
</tr>
<tr>
<td>☐ Survey Data</td>
</tr>
<tr>
<td>☐ Other</td>
</tr>
</tbody>
</table>


RESERVOIR INFORMATION FORM

Reservoir Description: Savery 18

Date of Inventory: July 30, 1997

Reservoir Location (1/4, Section, Township, Range): NENW Section 18, T13N, R89W

Drainage Name: Dutch Joe Creek

Stream Type (ephemeral, intermittent, etc.): Unknown (No flow but springs had been excavated and had water)

Source (Runoff, Springs, etc.): Spring areas had water but remaining areas dry

Terrain (flat, rolling, etc.): Rolling

Range description: valley and flood plain areas had grass and the hill sides were mostly sage.

Range Condition: fair

Description of Contributing Water Sources For Range Management: Springs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: Spring areas excavated along the drainage (one approx 1/4 mile down drainage and another approximately 1/2 mile down drainage)

Photo Log:

Film No. 3

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>21</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>22</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>
Access: Oil field roads from south of the site along drainage to the proposed site. The roads cross private property.

Location: The drainage at the proposed reservoir site has a wide valley with steep side slopes. The emergency spillway is proposed to be excavated out of the east side slope. The reservoir could be constructed at any depth. Some wetlands may be created along the tail water of the proposed reservoir.

The channel area has been excavated and appears to be spring fed. The valley appears to be wetlands.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

6,000' X 5,500' = 758 acres

Assumptions for Service Area:

- Springs up and down the drainage
- Steep ridges on east and west side of drainage
- Service area approximately ½ mile around reservoir
**LITTLE SNAKE RIVER**  
**WATER DEVELOPMENT PROJECT - LEVEL II**  
**PROJECT INVENTORY FORM**

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name:</th>
<th>Smiley Draw 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section</td>
<td>Stream:</td>
<td>Cottonwood Creek</td>
</tr>
<tr>
<td>Township</td>
<td>Contributing Drainage Area:</td>
<td>6.3 Sq. Mi.</td>
</tr>
<tr>
<td>Range</td>
<td>Reservoir Service Area:</td>
<td>716 Acres</td>
</tr>
</tbody>
</table>

**Description of Soil Suitability:**

- Borrow Source: ____________________________________________________________
- Foundation: ______________________________________________________________

**Accessibility (Location & Description):**

- Reservoir is on public land adjacent to County Road 503

**Ownership:**

- X Federal
- □ State
- □ Private

**Potential Project Beneficiaries:**

1. Snake River Land Co.
2. ____________________________
3. ____________________________
4. ____________________________

**Topographic Considerations:**

- Approximate Capacity: 13 Acre Ft.
- Approximate Dam Height: 17’
- Approximate Dam Length: 200’

**Existing Wetlands:**

- Did not appear to be any wetlands

**Wetland Enhancement Potential:**

- Poor

**Wildlife/Fishery Potential:**

- Poor

**Attached Information:**

- □ Location Map
- □ Photographic Documentation
- □ Topographic Sketch
- □ Survey Data
- □ Other ____________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Smiley Draw 3

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): NESE Section 3, T13N, R90W

Drainage Name: Cottonwood Creek

Stream Type (ephemeral, intermittent, etc.): Appears to be intermittent

Source (Runoff, Springs, etc.): Probably runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Grass with a little sage

Range Condition: Fair

Description of Contributing Water Sources For Range Management: Reservoirs

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM Reservoir approximately ½ mile northwest (Section 3, T13N, R90W)
2. BLM Reservoir approximately 3/4 mile southwest (Section 3, T13N, R90W)
3. Springs: None identified

Photo Log:

Film No. 2

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>23</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>24</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Smiley Draw 3
RESERVOIR INFORMATION FORM

Access: Reservoir is on public land adjacent to County Road 503

Location: The drainage area has steep side slopes with a relatively steep longitudinal slope. There was no flow at the time of the inventory and the supply is probably runoff. The emergency spillway is to be excavated out of the west side slope and discharge into a draw west of the proposed reservoir.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

6,000' X 5,000' = 716 acres

Assumptions for Service Area:

• No contributing water sources
• Terrain has rolling hills
• Service area approximately ½ mile around reservoir
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

<table>
<thead>
<tr>
<th>Location:</th>
<th>Reservoir Name: Smiley Draw 27</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 27</td>
<td>Stream: Cherokee Creek</td>
</tr>
<tr>
<td>Township 15</td>
<td>Contributing Drainage Area: 4.0 Sq. Mi.</td>
</tr>
<tr>
<td>Range 90</td>
<td>Reservoir Service Area: 637 acres</td>
</tr>
</tbody>
</table>

Description of Soil Suitability:
Borrow Source: ________________
Foundation: ________________

Ownership:
☐ Federal
☐ State
☐ Private

Accessibility (Location & Description):
Two track from County Road 503 across both private and public lands.

Potential Project Beneficiaries:
1. Montgomery Livestock
2. Snake River Land Co.
3. ________________
4. ________________

Topographic Considerations:
Approximate Capacity 97 Acre Ft.
Approximate Dam Height 35'
Approximate Dam Length 270'

Existing Wetlands:
Appears to be some wetlands along channel bottom

Wetland Enhancement Potential:
Possibly along reservoir fringes

Wildlife/Fishery Potential:
Good if supply is sufficient

Attached Information:
☐ Location Map
☐ Photographic Documentation
☐ Topographic Sketch
☐ Survey Data
☐ Other ________
RESERVOIR INFORMATION FORM

Reservoir Description: Smiley Draw 27

Date of Inventory: July 28, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 27, T15N, R90W

Drainage Name: Cherokee Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): Probably spring fed

Terrain (flat, rolling, etc.): Rolling (wide valley with steep ridges)

Range description: Primarily sage on the side hills and grass with some sage in the valleys

Range Condition: good

Description of Contributing Water Sources For Range Management: Reservoir

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs:
1. BLM reservoir approximately 1/4 mile south of proposed reservoir
2.
3.

Springs: None identified

Photo Log:

Film No. 2

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>20</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>21</td>
<td>Channel at proposed dike crossing</td>
</tr>
</tbody>
</table>

Little Snake River - Smiley Draw 27
**RESERVOIR INFORMATION FORM**

**Access:** A two track goes west from County Road 503 and travels south of five buttes. The two track crosses both private and public property. Another two track travels south to the ridge above the proposed reservoir site. From the top of the ridge the reservoir site is accessed on foot.

**Location:** The drainage has a wide valley with steep side slopes. The flood plain area upstream of the proposed reservoir site appears to be wetlands. The proposed dike can be constructed at any height desired. A location for an emergency spillway was not identified because both side hill are similar in that they are steep.

**Reservoir Service Area:** The dimensions used for the service area are scaled from drawings used to show the service area.

$$6,000' \times 2,000' + 4,500 \times 3,500 = 637 \text{ acres}$$

**Assumptions for Service Area:**

- BLM Reservoir ½ mile upstream
- Steep ridges on east and west side of drainage
- Service area approximately ½ mile around reservoir except the service area was extended to 1 mile down stream.
LITTLE SNAKE RIVER
WATER DEVELOPMENT PROJECT - LEVEL II
PROJECT INVENTORY FORM

Location:

Section 6
Township 14
Range 88

Reservoir Name: Tullis 6
Stream: Haystack Draw
Contributing Drainage Area: 0.6 Sq. Mi.
Reservoir Service Area: 603 Acres

Description of Soil Suitability:
Borrow Source: ________________________________
Foundation: ________________________________

Ownership:
□ Federal
□ State
X Private

Accessibility (Location & Description):
Two track off of County Road 602 across private lands.

Potential Project Beneficiaries:
1. Cobb, John T.
2. __________________________
3. __________________________
4. __________________________

Topographic Considerations:
Approximate Capacity 10 Acre Ft.
Approximate Dam Height 27'
Approximate Dam Length 150'

Existing Wetlands: Appears to be some along channel bottom and around existing pond area

Wetland Enhancement Potential: Some along reservoir fringes and tail water

Wildlife/Fishery Potential: Fair if supply is sufficient

Attached Information:
□ Location Map □ Photographic Documentation
□ Topographic Sketch □ Survey Data
□ Other __________________________
RESERVOIR INFORMATION FORM

Reservoir Description: Tullis 6

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): NENW Section 6, T14N, R88W

Drainage Name: Haystack Draw

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): probably springs and runoff

Terrain (flat, rolling, etc.): Rolling - (Wide valley with steep hills)

Range description: Sage and aspen trees on hill sides and grass in valley and open areas of the valley.

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

Springs: None identified

Photo Log:

Film No. 5

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>7</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>8</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Tullis 6
RESERVOIR INFORMATION FORM

Access: Two track from Browns Hill Road to Haystack Draw. Jeep trail from upper end of Haystack Draw around to the west side of the draw and down the west side to the proposed reservoir site. The two track and jeep trail crosses private property.

Location: Drainage has existing reservoir which is eroded and has water discharging over the face of the dike. Supply to the existing reservoir appears to be from springs and runoff. The drainage has a steep side slope on the east side and a more moderate slope on the west side. The emergency spillway is to be excavated out of the west side slope.

The existing channel has willows and aspens growing in it. The longitudinal slope of the drainage if fairly steep. It appears that wetlands exist along the channel of the drainage.

A large reservoir could be constructed at this site if the supply is sufficient.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings used to show the service area.

4,700' X 5,000' + 2,000 X 750 + 2,500 X 500 = 603 acres

Assumptions for Service Area:

• No contributing water sources
• Service area approximately ½ mile around reservoir except the service area was extended to 1 mile up and down the drainage.
## Little Snake River Water Development Project - Level II

### Project Inventory Form

**Location:**
- Section: 30
- Township: 15
- Range: 88

**Reservoir Name:** Tullis 30

**Stream:** Tributary to Savery Creek

**Contributing Drainage Area:** 1.2 Sq. Mi.

**Reservoir Service Area:** 505 Acres

**Ownership:**
- [ ] Federal
- [x] State
- [x] Private

**Accessibility (Location & Description):**

**Description of Soil Suitability:**
- Borrow Source:
  - ...
  - ...
- Foundation:
  - ...
  - ...

**Potential Project Beneficiaries:**
1. Jones, Peter Lee & Donna
2. Reba Y. Sheehan
3. Sheehan Ranches
4. 

**Topographic Considerations:**
- Approximate Capacity: 8 Acre Ft.
- Approximate Dam Height: 20'
- Approximate Dam Length: 192'

**Existing Wetlands:**
- Description, Acreage:
  - Appears to be some along the low flow channel

**Wetland Enhancement Potential:** Poor

**Wildlife/Fishery Potential:** Poor

**Attached Information:**
- [ ] Location Map
- [ ] Photographic Documentation
- [ ] Topographic Sketch
- [x] Survey Data
- [ ] Other
RESERVOIR INFORMATION FORM

Reservoir Description: Tullis 30

Date of Inventory: July 31, 1997

Reservoir Location (1/4, Section, Township, Range): SWNE Section 30, T15N, R88W

Drainage Name: Tributary to Savery Creek

Stream Type (ephemeral, intermittent, etc.): Flowing at time of inventory

Source (Runoff, Springs, etc.): probably springs and runoff

Terrain (flat, rolling, etc.): Rolling

Range description: Grass on tops of some hills and in valleys remainder primarily sage

Range Condition: fair

Description of Contributing Water Sources For Range Management: None identified

Type of Contributing Stream (ephemeral, intermittent, etc.): None identified

Description of existing Reservoirs: None identified

1. 
2. 
3. 

Springs: None identified

Photo Log:

Film No. 5

<table>
<thead>
<tr>
<th>Photo No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Upstream drainage area</td>
</tr>
<tr>
<td>4</td>
<td>Downstream drainage area</td>
</tr>
<tr>
<td>5</td>
<td>Channel at proposed dike</td>
</tr>
</tbody>
</table>

Little Snake River - Tullis 30
RESERVOIR INFORMATION FORM

Access: Reservoir located next to Browns Hill Road

Location: Drainage is small and fairly steep. The top of the proposed dike needs to be set so Browns Hill Road will not be flooded. The emergency spillway to be constructed on the opposite side of the dike to Browns Hill Road. The drainage was flowing at the time of the inventory and some wetlands exist along the channel.

Reservoir Service Area: The dimensions used for the service area are scaled from drawings showing the service area.

4,000' X 5,500' = 505 acres

Service Area Capacity

505 acres / 4 acres per AUM = 126 AUMs

Assumptions for Service Area:

- Savery creek 3/4 mile northwest of proposed reservoir
- Service area approximately ½ mile around reservoir
APPENDIX B

OWNERSHIP/LAND STATUS/
RESERVOIR SERVICE AREA MAPPING
LEGEND

- PROPOSED STOCKWATER POND
- EXISTING STOCKWATER POND
- BLM LANDS
- P.H. LIVESTOCK CO.
- OVERLAND TRAIL LAND & CATTLE CO.
- BLAKE SHEEP CO.
- ESPY, JAMES PHILLIP
- LESSEE
- GRAZING ALLOTMENT LESSEE
- SERVICE AREA

SCALE T = 3000'
LEGEND

- PROPOSED STOCKWATER POND
- STATE LANDS
- SLM LANDS
- BANJO SHEEP CO, LLC
- MEDICINE BOW, INC.
- REDY, TERENCE M.
- MARSH, FRANK & CORROLL MARIE
- RIPPLE, MAUREEN
- SERVICE AREA

MEDICINE BOW NATIONAL FOREST BOUNDARY

COTTONWOOD RIM NO. 10

LITTLE SNAKE RIVER BASIN STOCKWATER PONDS

COTTONWOOD RIM NO. 10
LAND STATUS
LEGEND

- PROPOSED STOCKWATER POND
- EXISTING STOCKWATER POND
- STATE LANDS
- BLM LANDS
- WEBER, GEIL RAY
- WEBER RANCH, INC.
- LESSEE
- GRAZING ALLOTMENT LESSEE
- SERVICE AREA

SCALE 1" = 3000'

PMPC
CONSULTING ENGINEERS
115 E BRIDGE AVE. P.O. BOX 370
SARATOGA, WYOMING 82331
307-235-4301

FILE NO. DOTYMTNSDWG
LIDSTONE & ANDERSON, INC.
LITTLE SNAKE RIVER BASIN STOCKWATER PONDS

JOB NO. 711000
SCALE 1" = 3000'
DRAWN BY: L.M.W.
DATE: 8-8-97

PMPC
CONSULTING ENGINEERS
115 E BRIDGE AVE. P.O. BOX 370
SARATOGA, WYOMING 82331
307-235-4301

FILE NO. DOTYMTNSDWG
LIDSTONE & ANDERSON, INC.
LITTLE SNAKE RIVER BASIN STOCKWATER PONDS

JOB NO. 711000
SCALE 1" = 3000'
DRAWN BY: L.M.W.
DATE: 8-8-97
LEGEND

- PROPOSED STOCKWATER POND
- EXISTING STOCKWATER POND
- BLM LANDS
- MONTGOMERY LIVESTOCK
- GRAZING ALLOTMENT BOUNDARY
- GRAZING ALLOTMENT LESSEE
- SERVICE AREA

SCALE 1" = 3000'

PMPC
CONSULTING ENGINEERS

DATE: 9/7/97

GARDEN GULCH NO. 32
LAND STATUS

SMALL RIVER LAND CO
LEGEND

PROPOSED STOCKWATER POND
EXISTING STOCKWATER POND
STATE LANDS
BLM LANDS
SANDSTONE SHEEP COMPANY
LEGEE
Grazing Allotment Lessee
LESSEE
COONS, MARTHA J. (HALL) ETAL
ROCHELLE, CURTIS TRUSTEE ETAL
STRATTON SHEEP CO.

SCALE: 1' = 3000'

PMPC
CONSULTING ENGINEERS
150 E BRIDGE AVE P.O. BOX 372
SARATOGA, WYOMING 82331
307-354-6801

JOB NO. 771000
FILE NO. PINEGROVE1
SCALE: 1' = 3000'
DRAWN BY: LAW
DATE 5-7-87

LEIGHTON & ANDERSON, INC.
LITTLE SNAKE RIVER BASIN STOCKWATER PONDS

PINE GROVE RANCH NO. 1
LAND STATUS

OF 1
APPENDIX C

MEMORANDUM: CONDITION OF EXISTING DAM SITES
MEMORANDUM

TO: Brad Anderson
    Lidstone and Anderson

FROM: Shawn Steiner

DATE: November 25, 1997

RE: CONDITION OF OBSERVED DAM SITES
    LITTLE SNAKE RIVER CONSERVATION DISTRICT
    CARBON COUNTY, WYOMING

Per your request, we are summarizing our observations of the some of the existing dams sites observed during our field reconnaissance. Three types of existing dam sites were observed; (1) Dams that have currently failed which were reportedly constructed during the 1950's to the 1970's. (2) Dam sites that were holding water and were reportedly constructed in the 1990's, and (3) A dam site that was reportedly constructed in the Fall of 1996, that was already showing significant signs of potential failure.

The dams observed that had failed, which were constructed approximately 20 to 40 years ago, were reportedly constructed by the BLM or National Job Corp Projects. These dams appear to have been constructed in accordance with current design guidelines, regarding up and down stream slopes and spillway construction. However, these dams appear to have failed due to erosion degrading the embankment. Additionally, some of the erosion problems appear to have been the result of the spillway erosion cutting into the embankment and thus causing failure. Some of the common problems that appear to be associated with these dams is that little to no vegetation was growing in the area of the failure. Additionally, the soils around the failure areas appear to primarily consist of a silty sand.

Three dam sites were visited that were holding water. One dam site was observed from a distance but appeared to be functioning well. The up and down stream slopes appeared to be constructed at the appropriate slope and was well vegetated. The spillway was well vegetated and discharged well beyond the downstream toe of the dam. Two other dam sites were visited that were more recently constructed and generally similar in condition. The up and down stream slopes appear to have been constructed steeper than the standard 3H:1V and 2H:1V, respectively. Little to no vegetation was present on the slopes or the spillway. The upstream face of the dams were experiencing erosion due to wave action, and the spillways were experiencing varying degrees of erosion, especially in the area where the spillway reenters the stream channel.
The dam site that was constructed in the Fall of 1996, was observed to be experiencing significant signs of potential failure. The most significant sign of failure was the seepage along the right abutment. The seepage is the likely cause of erosion of the embankment at the interface of the downstream side of the embankment and the abutment. Additionally, the up and down stream slopes appeared to be constructed at a slope of approximately 1H:1V. Erosion was occurring on the upstream face of the dam due to wave action. The surficial embankment materials contained a significant amount of vegetation and silty soils. Another item of possible significance, is it that according to Larry Hicks, Little Snake River Conservation District Director, the dam was constructed in approximately 1 day without any supervision.

In general, the dam problems appear to be related to materials and construction. If the dams had been constructed with an appropriate material and in accordance with the current design guidelines, the dams experiencing some problems are likely to be in better condition. However, it should be noted that the dams that were built 20 or more years ago may have performed satisfactorily for the original design life of the dams.
APPENDIX D

PRELIMINARY DESIGN AND CONSTRUCTION GUIDELINES
DESIGN AND CONSTRUCTION GUIDELINES

General

A cursory review of aerial photographs indicated the existence of several previously constructed stock ponds within the Little Snake River Basin. In general, these ponds were designed and constructed by the BLM, District and individual land owners. It is likely that a variety of guidelines were utilized during the design and construction of these stock ponds and reservoirs.

To assist in the design and construction of this Level II project as well as future livestock ponds and reservoirs, preliminary guidelines have been prepared. Several entities publish procedures, guidelines and specifications for the design and construction of these ponds and reservoirs. These entities include the Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS, formerly the SCS), Bureau of Reclamation (BOR), and State Engineer’s Office (SEO). For the purposes of this document, all impoundments constructed within the State of Wyoming fall under the jurisdiction of the SEO. Consequently, any embankment constructed within Wyoming must comply with the SEO’s rules and regulations.

In reviewing the available information, adherence to the rules and regulations promulgated by the SEO as well as the procedures published by the NRCS in Pond 378 Technical Guide, is recommended. It is noted that the design guidelines documented in Pond 378 Technical Guide are very similar to those design guidelines established by the SEO. The design and construction guidelines presented in this chapter pertain to all structures which meet the following criteria:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways or railroads; or result in interruption of the use or service of public utilities. These dams are classified as low hazard structures located in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

2. The effective height of the embankment is less than 35 feet. The effective height of the embankment is defined as the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the embankment.

3. The product of the storage, in acre-feet, times the effective height of the dam is less than 3,000. Storage is the volume in the reservoir below the elevation of the crest of the emergency spillway.

In addition to the above criteria, the site conditions should be such that runoff from the design storm...
should safely pass through the principal spillway, or the emergency spillway, or a combination of the principal and emergency spillways.

It is important to remember that the SEO classifies dam embankments as either stock ponds (those embankments less than 20 feet in height and capacity less than 20 acre-feet) or reservoirs (embankment height greater than 20 feet or capacity greater than 50 acre-feet). Reservoirs must meet additional permitting requirements per the safety of dam regulations.

References

The following references were reviewed and evaluated during the preparation of the design and construction guidelines.


Design Guidelines

The following information summarizes the guidelines for designing a small dam embankment meeting the criteria previously described. The design of the dam embankments should be completed or directed by a licensed professional engineer registered in the State of Wyoming. The accountability for the design and construction of the dam embankment should rest with the professional engineer. Please refer to Figure 1 for typical drawings related to the design of the dam embankment.
Figure 1. Typical Design Drawings
Foundation:

- The foundation conditions for any dam embankment should be determined by an adequate subsurface exploration/investigation. The subsurface conditions should be reviewed by a qualified geotechnical engineer to verify that the foundation materials provide adequate support for the given site conditions.

- A cutoff trench should be included to control seepage and piping along the foundation of the embankment. The cutoff trench should extend a minimum of 3 feet into the bedrock materials and should have a minimum width of 12 feet. The cutoff trench should be constructed with a maximum side slope of 1H:1V, and the end slopes should have a maximum slope of 3H:1V. The cutoff trench should be constructed of clayey soils classified as CH or CL according to the Unified Soil Classification System. The cutoff trench should not consist of materials classified as ML, MH, OH, PT, GW, GP, SW and SP.

- Seepage control should be included if: (1) pervious layers are not adequately intercepted by the cutoff trench; (2) seepage creates a swamping condition downstream; (3) such control is necessary to maintain a stable embankment; or (4) special problems require drainage for a stable dam. Alternative seepage control measures include foundation, abutment, or embankment drains; reservoir blanketing with an impervious material; or a combination of these measures.

Earth Embankment:

- The embankments should be constructed of clayey soils classified as CH or CL according to the Unified Soil Classification System. The embankments should not consist of materials classified as ML, MH, OH, PT, GW, GP, SW and SP.

- The embankments should be constructed with upstream slopes of 4H:1V and downstream slopes of 2H:1V.

- The crest width of the embankment should be 1/5th of the height plus 4 feet, but no less than 8 feet; if the embankment serves as a road, the crest width should be a minimum of 16 feet for one-way traffic.

- The freeboard between the crest of the emergency spillway and the dam crest should be a minimum of 5 feet. The minimum freeboard between the dam crest and the emergency spillway flowing full should be 1.5 feet.

Spillways:

- A spillway is required to pass the peak inflow from the design storm event without overtopping the dam embankment. The spillway for the dam embankments may consist of either an emergency spillway, principal spillway or combination of both
emergency and principal spillways. Typically, an emergency spillway will be designed with a small conduit (pipe) serving as the principal spillway to discharge trickle flows. Regardless of the type of spillway, it is recommended that the capacity of the spillway should be sufficient to convey the peak discharge associated with the 50-year, 24-hour storm event.

- The maximum depth of flow in the emergency spillway should not exceed 2.5 feet. Maximum velocity through the spillway should not exceed values in the SCS Engineering Field Manual. Where these values cannot be achieved, the spillway must be stabilized with rock or other stabilization measures.

- Where a principal spillway is utilized in conjunction with an emergency spillway, a minimum diameter of 12 inches is recommended by the NRCS. If the function of the principal spillway is to discharge trickle flows, the minimum diameter of the pipe can be reduced to 8 inches.

Construction Guidelines

The construction of the reservoir should be directed by a qualified professional engineer registered in the State of Wyoming. The engineer should verify that the site has been adequately stripped and that the foundation has been properly prepared and is consistent with the materials encountered within the subsurface exploration. Additionally, the engineer should verify that the embankment materials are suitable for placement and that the design and construction recommendations have been followed. Accountability for the construction of the dam embankment and spillway facilities in accordance with the contract documents and specifications will rest with the professional engineer.

Site Preparation:

- The surface area to be covered by the embankment, borrow areas and emergency spillway should be thoroughly cleared and stripped of vegetative matter, brush, trees, stumps, roots, loose rocks and other objectionable materials including sand, gravel, silt, and debris in channels within the foundation area.

- Topsoil should be removed and conserved in stockpiles. After construction of the embankment, topsoil should be uniformly placed over cut and fill areas above the high water line with priority to the top and upstream slopes of the dam, spillway, and borrow pits.

- Borrow areas should not be located within 25 feet of the upstream toe of the dam.
Earth Embankment:

- After clearing, stripping, bank sloping and excavation have been completed, the foundation and cutoff trench should be scarified to a minim depth of 6 inches. Scarified furrows should be a maximum of 3 feet apart and parallel to the axis of the dam. The scarified surface should be compacted with the first layer of embankment materials.

- Embankment materials should be free of sod, roots, brush, snow, other waste matter and rocks of a shape or size that will interfere with uniform placement of materials in layers of specified thickness. Embankment materials should not be placed when either the materials or the surface on which they will be placed, are frozen or too wet for satisfactory compaction.

- Embankment materials should be placed parallel to the axis of the dam in even, continuous, horizontal layers not more than 8 inches in thickness. The full cross section of the dam should be maintained as each successive layer is placed. Distribution and gradation of materials throughout the earthfill should be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material.

- The embankment materials should be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D698, and within minus 1 percent to plus 3 percent of the optimum moisture content.

Summary

Several agencies have criteria and guidelines for the design and construction of stock ponds and reservoirs. Regardless of the agency which promulgates the criteria or guidelines, they must meet or conform to standard engineering practices associated with the design and construction of stock ponds and reservoirs. Where applicable, the requirements of the SEQ with respect to dam safety must be considered.

Given the potential problems with foundation stability, it is recommended that a subsurface exploration program be conducted at every stock pond/reservoir location funded by the State of Wyoming. With respect to the design life of the stock pond or reservoir, the criteria/guidelines should ensure the longevity of the structure for the duration of the loan, as a minimum. If a 25-year construction loan is provided, the facilities should be designed to be operational and functional for 25 years. Finally, all work associated with the design and construction of the stock ponds or reservoirs should be directed or supervised by a licensed engineer registered in the State of Wyoming. Accountability for the design and construction of the stock pond/reservoir will rest with the
professional engineer.

Should no loans be required, it is recommended that the WWDC seek assurance from the District that the structures be maintained for at least 25 years. Further, the structures should be designed and constructed in a manner that will allow for a design life of at least 25 years with minimal maintenance.
APPENDIX E

HYDROLOGIC/FLOOD/SEDIMENT YIELD ANALYSES
**Hydraulic Analysis**

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A)</th>
<th>Annual Precipitation (P_R)</th>
<th>Annual Sediment Prod.</th>
<th>Reservoir Surface Area</th>
<th>Geographical Factor (G_f)</th>
<th>Net Evaporation</th>
<th>Reservoir Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sq.Mi.</td>
<td>Inches</td>
<td>Tons/Sq.Mi./Year</td>
<td>Acres</td>
<td></td>
<td>Acre feet</td>
<td>Acre Ft</td>
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<tr>
<td>3.8</td>
<td>11</td>
<td>400.0</td>
<td>5.5</td>
<td>1.0</td>
<td>15.6</td>
<td>35.8</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.59(A^{-0.03})} \times P_R^{0.6} \times G_f \]
\[ P_5 = 10.6 \times A^{0.58(A^{-0.03})} \times P_R^{0.81} \times G_f \]
\[ P_{10} = 13.8 \times A^{0.55(A^{-0.03})} \times P_R^{0.9} \times G_f \]
\[ P_{25} = 19.4 \times A^{0.53(A^{-0.03})} \times P_R^{0.98} \times G_f \]
\[ P_{50} = 24.2 \times A^{0.52(A^{-0.03})} \times P_R^{1.02} \times G_f \]
\[ P_{100} = 30.1 \times A^{0.51(A^{-0.03})} \times P_R^{1.05} \times G_f \]
\[ Q_a = 0.0021 \times A^{0.88} \times P_R^{1.19} \]

59.8 cfs
151.6 cfs
241.8 cfs
401.4 cfs
544.1 cfs
718.0 cfs
85.4 acre ft

Existing Reservoirs & Senior Appropriators
2.4 acre ft

**Subtotal (Drainage Yield)**

83.0 acre ft

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>Sediment Yield (over 20 yrs)</th>
<th>Seepage</th>
<th>Evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.8 acre ft</td>
<td>14 acre ft</td>
<td></td>
<td>15.6 acre ft</td>
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### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>35.8</td>
<td>35.8</td>
<td>35.8</td>
<td>35.8</td>
<td>35.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.7</td>
<td>3.5</td>
<td>7.0</td>
<td>10.5</td>
<td>14.0</td>
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### Seepage

**Subtotal (Reservoir Yield)**

35.1 32.3 28.8 25.3 21.8

### Livestock (18 gal/AU/day)

<table>
<thead>
<tr>
<th>Availability in AUM's</th>
</tr>
</thead>
<tbody>
<tr>
<td>21,178.9</td>
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Little Snake River - Baggs 27

WWDC Level II
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A)</th>
<th>Annual Precipitation (P_R)</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
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</thead>
<tbody>
<tr>
<td>38.1 sq.mi.</td>
<td>11 inches</td>
<td>400.0</td>
<td>50.1</td>
<td>1.0</td>
<td>142.0</td>
<td>375.4</td>
</tr>
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</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.55(A^-0.03)} \times P_R^{0.68} \times G_f \]
\[ P_5 = 10.6 \times A^{0.55(A^-0.03)} \times P_R^{0.81} \times G_f \]
\[ P_{10} = 13.8 \times A^{0.55(A^-0.03)} \times P_R^{0.9} \times G_f \]
\[ P_{25} = 19.4 \times A^{0.55(A^-0.03)} \times P_R^{0.98} \times G_f \]
\[ P_{50} = 24.2 \times A^{0.52(A^-0.03)} \times P_R^{1.02} \times G_f \]
\[ P_{100} = 30.1 \times A^{0.51(A^-0.03)} \times P_R^{1.05} \times G_f \]

\[ Q_a = 0.0021 \times A^{0.88} \times P_R^{1.19} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 629.2 acre ft

Reservoir Information

Reservoir Capacity 375.4 acre ft
Sediment Yield (over 20 yrs)* 49.0 acre ft
Seepage acre ft
Evaporation 142.0 acre ft

Water Use

<table>
<thead>
<tr>
<th></th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
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<tbody>
<tr>
<td>Reservoir Capacity (acre ft)</td>
<td>375.4</td>
<td>375.4</td>
<td>375.4</td>
<td>375.4</td>
<td>375.4</td>
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<tr>
<td>Sediment Yield (acre ft)</td>
<td>2.4</td>
<td>12.2</td>
<td>24.5</td>
<td>36.7</td>
<td>49.0</td>
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<tr>
<td>Evaporation (acre ft)</td>
<td>142.0</td>
<td>142.0</td>
<td>142.0</td>
<td>142.0</td>
<td>142.0</td>
</tr>
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</table>

Subtotal (Reservoir Yield) 231.0 221.2 209.0 196.7 184.5

Livestock (18 gal/AU/day)

Availability in AUMs 139,382.9 133,472.0 126,083.5 118,694.9 111,306.3

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
**HYDRAULIC ANALYSIS**

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A)</th>
<th>Annual Precipitation (P)</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
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<tr>
<td>28.1 11</td>
<td>400.0</td>
<td>14.6</td>
<td>1.0</td>
<td>41.4</td>
<td>109.2</td>
<td></td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) High Desert Region

\[
P_2 = 6.66*A^{0.59(A^-0.03)}*P^0.6*G_f = 166.6 \text{ cfs}
\]
\[
P_5 = 10.6*A^{0.56(A^-0.03)}*P^0.81*G_f = 400.7 \text{ cfs}
\]
\[
P_{10} = 13.8*A^{0.55(A^-0.03)}*P^0.9*G_f = 628.1 \text{ cfs}
\]
\[
P_{25} = 19.4*A^{0.53(A^-0.03)}*P^0.98*G_f = 1,007.1 \text{ cfs}
\]
\[
P_{50} = 24.2*A^{0.52(A^-0.03)}*P^1.02*G_f = 1,341.6 \text{ cfs}
\]
\[
P_{100} = 30.1*A^{0.51(A^-0.03)}*P^1.05*G_f = 1,739.8 \text{ cfs}
\]
\[
Q_a = 0.0021*A^{0.88}*P^{1.19} = 496.7 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

**Subtotal (Drainage Yield)** 371.6 acre ft

### Reservoir Information

- Reservoir Capacity 109.2 acre ft
- Sediment Yield (over 20 yrs)* 36.1 acre ft
- Seepage acre ft
- Evaporation 41.4 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity (acre ft)</td>
<td>109.2</td>
<td>109.2</td>
<td>109.2</td>
<td>109.2</td>
<td>109.2</td>
</tr>
<tr>
<td>Sediment Yield (acre ft)</td>
<td>1.8</td>
<td>9.0</td>
<td>18.1</td>
<td>27.1</td>
<td>36.1</td>
</tr>
<tr>
<td>Evaporation (acre ft)</td>
<td>41.4</td>
<td>41.4</td>
<td>41.4</td>
<td>41.4</td>
<td>41.4</td>
</tr>
</tbody>
</table>

**Subtotal (Reservoir Yield)** 66.0 acre ft

Livestock (18 gal/AU/day) 39839.9 35480.4 30031.1 24581.8 19132.5

*USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
## Hydraulic Analysis

### Site Information

<table>
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<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (Gf)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6</td>
<td>11</td>
<td>200.0</td>
<td>13.6</td>
<td>0.8</td>
<td>38.5</td>
<td>68.8</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) High Desert Region

\[
P_2 = 6.66 A^{0.59(A^{-0.03})} P_f^{0.6} G_f^{0.5}
\]

\[
P_5 = 10.6 A^{0.56(A^{-0.03})} P_f^{0.81} G_f^{0.5}
\]

\[
P_{10} = 13.8 A^{0.55(A^{-0.03})} P_f^{0.9} G_f^{0.5}
\]

\[
P_{25} = 19.4 A^{0.53(A^{-0.03})} P_f^{0.98} G_f^{0.5}
\]

\[
P_{50} = 24.2 A^{0.52(A^{-0.03})} P_f^{1.02} G_f^{0.5}
\]

\[
P_{100} = 30.1 A^{0.51(A^{-0.03})} P_f^{1.05} G_f^{0.5}
\]

\[
Q_a = 0.0021 A^{0.88} P_f^{1.19}
\]

- Existing Reservoirs & Senior Appropriators
  - Subtotal (Drainage Yield) 153.1 acre ft

### Reservoir Information

- Reservoir Capacity 68.8 acre ft
- Sediment Yield (over 20 yrs) 4.9 acre ft
- Seepage acre ft
- Evaporation 38.5 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
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<tr>
<td>Reservoir Capacity</td>
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<td>68.8</td>
<td>68.8</td>
<td>68.8</td>
<td>68.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.2</td>
<td>1.2</td>
<td>2.4</td>
<td>3.7</td>
<td>4.9</td>
</tr>
<tr>
<td>Evaporation (acre ft)</td>
<td>38.5</td>
<td>38.5</td>
<td>38.5</td>
<td>38.5</td>
<td>38.5</td>
</tr>
</tbody>
</table>

- Subtotal (Reservoir Yield) 30.0 29.0 27.8 26.6 25.4

- Livestock (18 gal/AU/day) Availability in AUM’s
  - 18115.1 17525.6 16788.7 16051.7 15314.8

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_r) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Surface Area Factor (G)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>9.5</td>
<td>11</td>
<td>200.0</td>
<td>2.6</td>
<td>0.8</td>
<td>7.4</td>
<td>14.8</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 * A^{0.59(A-0.03)} * P_R^{0.6} * G_f \]  
77.7 cfs

\[ P_5 = 10.6 * A^{0.56(A-0.03)} * P_R^{0.81} * G_f \]  
192.2 cfs

\[ P_{10} = 13.8 * A^{0.55(A-0.03)} * P_R^{0.9} * G_f \]  
304.0 cfs

\[ P_{25} = 19.4 * A^{0.53(A-0.03)} * P_R^{0.98} * G_f \]  
496.4 cfs

\[ P_{50} = 24.2 * A^{0.52(A-0.03)} * P_R^{1.02} * G_f \]  
667.3 cfs

\[ P_{100} = 30.1 * A^{0.51(A-0.03)} * P_R^{1.05} * G_f \]  
873.4 cfs

\[ Q_* = 0.0021 * A^{0.88} * P_R^{1.19} \]  
191.2 acre ft

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield)  
187.2 acre ft

Reservoir Information

Reservoir Capacity 14.8 acre ft

Sediment Yield (over 20 yrs)* 6.1 acre ft

Seepage acre ft

Evaporation 0.0 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
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<td>14.8</td>
<td>14.8</td>
<td>14.8</td>
<td>14.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>2.9</td>
<td>14.6</td>
<td>29.2</td>
<td>43.8</td>
<td>58.3</td>
</tr>
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Subtotal (Reservoir Yield)  
19.1 7.4 0.0 0.0 0.0

Livestock (18 gal/AU/day)  
11514.6 4475.1 0.0 0.0 0.0

Availability in AUM's

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_r) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.8</td>
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<td>200.0</td>
<td>3.9</td>
<td>0.8</td>
<td>11.1</td>
<td>22.1</td>
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Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.59(A^-0.03)} \times P_R^{0.6} \times G_f \]
\[ P_5 = 10.6 \times A^{0.56(A^-0.03)} \times P_R^{0.81} \times G_f \]
\[ P_{10} = 13.8 \times A^{0.55(A^-0.03)} \times P_R^{0.9} \times G_f \]
\[ P_{25} = 19.4 \times A^{0.53(A^-0.03)} \times P_R^{0.98} \times G_f \]
\[ P_{50} = 24.2 \times A^{0.52(A^-0.03)} \times P_R^{1.02} \times G_f \]
\[ P_{100} = 30.1 \times A^{0.51(A^-0.03)} \times P_R^{1.05} \times G_f \]
\[ Q_s = 0.0021 \times A^{0.88} \times P_R^{1.19} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 100.9 acre ft

Reservoir Information

Reservoir Capacity 22.1 acre ft
Sediment Yield (over 20 yrs) 8.815 acre ft
Seepage acre ft
Evaporation 11.1 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
<td>22.1</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.4</td>
<td>2.2</td>
<td>4.4</td>
<td>6.6</td>
<td>8.8</td>
</tr>
<tr>
<td>Livestock (18 gal/AU/day) Availability in AUMs</td>
<td>13,069</td>
<td>12,005</td>
<td>10,675</td>
<td>9,346</td>
<td>8,016</td>
</tr>
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</table>

Subtotal (Reservoir Yield) 21.7

Little Snake River - Bridger Pass 32
# HYDRAULIC ANALYSIS

## Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2</td>
<td>14</td>
<td>200.0</td>
<td>0.1</td>
<td>None</td>
<td>0.3</td>
<td>0.7</td>
</tr>
</tbody>
</table>

## Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \times A^{0.81} \times P_R^{1.13} \quad 2.7 \text{ cfs}
\]

\[
P_5 = 2.36 \times A^{0.79} \times P_R^{0.75} \quad 5.2 \text{ cfs}
\]

\[
P_{10} = 5.35 \times A^{0.78} \times P_R^{0.59} \quad 7.2 \text{ cfs}
\]

\[
P_{25} = 13.5 \times A^{0.77} \times P_R^{0.28} \quad 10.7 \text{ cfs}
\]

\[
P_{50} = 23.8 \times A^{0.77} \times P_R^{0.25} \quad 13.3 \text{ cfs}
\]

\[
P_{100} = 40.7 \times A^{0.76} \times P_R^{0.13} \quad 16.9 \text{ cfs}
\]

\[
Q_a = 0.013 \times A^{0.93} \times P_R^{1.43} \quad 91.7 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

**Subtotal (Drainage Yield)**

91.7 acre ft

## Reservoir Information

- Reservoir Capacity: 0.67 acre ft
- Sediment Yield (over 20 yrs): 0.37 acre ft
- Seepage: acre ft
- Evaporation: 0.3 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
<td>0.67</td>
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<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
</tr>
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</table>

**Subtotal (Reservoir Yield)**

0.67 acre ft

Livestock (18 gal/AU/day)

<table>
<thead>
<tr>
<th>Availability in AUMs</th>
<th>Livestock Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 gal/AU/day</td>
<td>404</td>
</tr>
<tr>
<td>5 Years</td>
<td>344</td>
</tr>
<tr>
<td>10 Years</td>
<td>284</td>
</tr>
<tr>
<td>15 years</td>
<td>223</td>
</tr>
<tr>
<td>20 Years</td>
<td>163</td>
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</table>

Little Snake River - Browns Hill 10  

WWDC Level II
### HYDRAULIC ANALYSIS

#### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.4</td>
<td>14</td>
<td>200.0</td>
<td>2.9</td>
<td>None</td>
<td>7.5</td>
<td>17.0</td>
</tr>
</tbody>
</table>

#### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[ P_2 = 0.51A^{0.81}P_R^{1.13} \]
\[ P_5 = 2.36A^{0.79}P_R^{0.78} \]
\[ P_{10} = 5.35A^{0.78}P_R^{0.59} \]
\[ P_{25} = 13.5A^{0.77}P_R^{0.38} \]
\[ P_{50} = 23.8A^{0.77}P_R^{0.25} \]
\[ P_{100} = 40.7A^{0.76}P_R^{0.13} \]
\[ Q_a = 0.013A^{0.93}P_R^{1.43} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 560.4 acre ft

#### Reservoir Information

Reservoir Capacity 17 acre ft
Sediment Yield (over 20 yrs) 2.57 acre ft
Seepage acre ft
Evaporation 7.5 acre ft

#### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>17</td>
<td>17</td>
<td>17.0</td>
<td>17.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.6</td>
<td>1.3</td>
<td>1.9</td>
<td>2.6</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 16.9

Livestock (18 gal/AU/day) 5,659.6
Availability in AUM's 4,185.8
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>20.5</td>
<td>14</td>
<td>200.0</td>
<td>6.8</td>
<td>None</td>
<td>17.6</td>
<td>38.5</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
\begin{align*}
P_2 &= 0.51 \times A^{0.81} \times P_R^{1.13} & \quad 116.2 \text{ cfs} \\
P_5 &= 2.36 \times A^{0.79} \times P_R^{0.78} & \quad 201.0 \text{ cfs} \\
P_{10} &= 5.35 \times A^{0.78} \times P_R^{0.59} & \quad 267.8 \text{ cfs} \\
P_{25} &= 13.5 \times A^{0.77} \times P_R^{0.38} & \quad 376.6 \text{ cfs} \\
P_{50} &= 23.8 \times A^{0.77} \times P_R^{0.25} & \quad 471.2 \text{ cfs} \\
P_{100} &= 40.7 \times A^{0.76} \times P_R^{0.13} & \quad 569.5 \text{ cfs} \\
Q_a &= 0.013 \times A^{0.93} \times P_R^{1.43} & \quad 6,800.7 \text{ acre ft} \\
\end{align*}
\]

Existing Reservoirs & Senior Appropriators

\[\text{Subtotal (Drainage Yield)} \quad 6,677.7 \text{ acre ft}\]

### Reservoir Information

- **Reservoir Capacity**: 38.5 acre ft
- **Sediment Yield (over 20 yrs)**: 13.2 acre ft
- **Seepage**: acre ft
- **Evaporation**: 17.6 acre ft

### Water Use

\[
\begin{array}{ccccccc}
\text{Water Use} & \text{1 Year} & \text{5 Years} & \text{10 Years} & \text{15 years} & \text{20 Years} \\
\hline
\text{Reservoir Capacity} & 38.5 & 38.5 & 38.5 & 38.5 & 38.5 \\
\text{Sediment Yield} & 0.7 & 3.3 & 6.6 & 9.9 & 13.2 \\
\text{Evaporation (acre ft)} & 17.6 & 17.6 & 17.6 & 17.6 & 17.6 \\
\text{Subtotal (Reservoir Yield)} & 20.3 & 17.6 & 14.3 & 11.1 & 7.8 \\
\text{Livestock (18 gal/AU/day)} & 12,233.3 & 10,643.2 & 8,655.4 & 6,667.7 & 4,679.9 \\
\text{Availability in AUM's} & \\
\end{array}
\]

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
## Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>20</td>
<td>0.0</td>
<td>2.1</td>
<td>None</td>
<td>4.4</td>
<td>10.5</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \cdot A^{0.881} \cdot P_R^{1.13} \quad 36.7 \text{ cfs}
\]

\[
P_5 = 2.36 \cdot A^{0.79} \cdot P_R^{0.78} \quad 58.2 \text{ cfs}
\]

\[
P_{10} = 5.35 \cdot A^{0.78} \cdot P_R^{0.59} \quad 73.8 \text{ cfs}
\]

\[
P_{25} = 13.5 \cdot A^{0.77} \cdot P_R^{0.38} \quad 98.2 \text{ cfs}
\]

\[
P_{50} = 23.8 \cdot A^{0.77} \cdot P_R^{0.25} \quad 117.3 \text{ cfs}
\]

\[
P_{100} = 40.7 \cdot A^{0.76} \cdot P_R^{0.13} \quad 138.5 \text{ cfs}
\]

\[
Q_a = 0.013 \cdot A^{0.93} \cdot P_R^{1.43} \quad 1,896.1 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

<table>
<thead>
<tr>
<th></th>
<th>100.0 acre ft</th>
</tr>
</thead>
</table>

**Subtotal (Drainage Yield)** 1,796.1 acre ft

## Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>10.5 acre ft</th>
</tr>
</thead>
</table>

Sediment Yield (over 20 yrs) 0 acre ft

Seepage acre ft

Evaporation 4.4 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
<td>10.5</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Subtotal (Reservoir Yield)** 10.5 10.5 10.5 10.5 10.5

Livestock (18 gal/AU/day) 3,695.7 3,695.7 3,695.7 3,695.7 3,695.7

Availability in AUM's
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_s)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>20</td>
<td>0.0</td>
<td>0.3</td>
<td>None</td>
<td>0.6</td>
<td>1.8</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[ P_2 = 0.51 A^{0.81} P_R^{1.13} \]

\[ P_5 = 2.36 A^{0.79} P_R^{0.78} \]

\[ P_{10} = 5.35 A^{0.78} P_R^{0.59} \]

\[ P_{25} = 13.5 A^{0.77} P_R^{0.38} \]

\[ P_{50} = 23.8 A^{0.77} P_R^{0.25} \]

\[ P_{100} = 40.7 A^{0.76} P_R^{0.13} \]

\[ Q_d = 0.013 A^{0.93} P_R^{1.43} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 424.4 acre ft

Reservoir Information

Reservoir Capacity 1.8 acre ft

Sediment Yield (over 20 yrs) 0 acre ft

Seepage acre ft

Evaporation 0.6 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
<td>1.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
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<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 1.8

Livestock (18 gal/AU/day) 1,086

Availability in AUMs 1,086
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_J Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (Gf)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>35.3</td>
<td>12</td>
<td>500.0</td>
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<td>1.0</td>
<td>19.8</td>
<td>76.0</td>
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</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.59(A^{0.03})_P} \times P_0.6 \times G_f \]
\[ P_5 = 10.6 \times A^{0.56(A^{0.03})_P} \times P_0.81 \times G_f \]
\[ P_{10} = 13.8 \times A^{0.55(A^{0.03})_P} \times P_0.9 \times G_f \]
\[ P_{25} = 19.4 \times A^{0.53(A^{0.03})_P} \times P_0.98 \times G_f \]
\[ P_{50} = 24.2 \times A^{0.52(A^{0.03})_P} \times P_1.02 \times G_f \]
\[ P_{100} = 30.1 \times A^{0.51(A^{0.03})_P} \times P_1.05 \times G_f \]
\[ Q_a = 0.0021 \times A^{0.88 \times P} \times 1.19 \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 663.1 acre ft

Reservoir Information

Reservoir Capacity 76 acre ft
Sediment Yield (over 20 yrs)* 56.726 acre ft
Seepage acre ft
Evaporation 0.0 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
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</thead>
<tbody>
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<td>76</td>
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<td>76.0</td>
<td>76.0</td>
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<tr>
<td>Sediment Yield</td>
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<td>28.4</td>
<td>42.5</td>
<td>56.7</td>
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<tr>
<td>Subtotal (Reservoir Yield)</td>
<td>73.2</td>
<td>61.8</td>
<td>47.6</td>
<td>33.5</td>
<td>19.3</td>
</tr>
</tbody>
</table>

Livestock (18 gal/AU/day) 44,146 37,300 28,743.4 20,186.4 11,629.5

Availability in AUMs

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographical Factor (Gc)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
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</thead>
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<tr>
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<td>300.0</td>
<td>0.1</td>
<td>1.0</td>
<td>0.3</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.59(A-0.03)} \times P_{R}^{0.6} \times G_f \]
\[ P_5 = 10.6 \times A^{0.56(A-0.03)} \times P_{R}^{0.81} \times G_f \]
\[ P_{10} = 13.8 \times A^{0.55(A-0.03)} \times P_{R}^{0.9} \times G_f \]
\[ P_{25} = 19.4 \times A^{0.53(A-0.03)} \times P_{R}^{0.98} \times G_f \]
\[ P_{50} = 24.2 \times A^{0.52(A-0.03)} \times P_{R}^{1.02} \times G_f \]
\[ P_{100} = 30.1 \times A^{0.51(A-0.03)} \times P_{R}^{1.05} \times G_f \]
\[ Q_a = 0.0021 \times A^{0.88} \times P_{R}^{1.19} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 26.7 acre ft

Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>Sediment Yield (over 20 yrs)</th>
<th>Seepage</th>
<th>Evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6 acre ft</td>
<td>2.48 acre ft</td>
<td></td>
<td>0.3 acre ft</td>
</tr>
</tbody>
</table>

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.6</td>
<td>1.2</td>
<td>1.9</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 0.5 acre ft

Livestock (18 gal/AU/day) Availability in AUMs

Little Snake River - Dixon 15
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_a) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.3</td>
<td>13</td>
<td>300.0</td>
<td>2.4</td>
<td>1.0</td>
<td>6.4</td>
<td>15.0</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) High Desert Region

\[
P_2 = 6.66 \times A^{0.59(A^{-0.03})} \times P_R^{0.6} \times G_f \quad 141.1 \text{ cfs}
\]

\[
P_3 = 10.6 \times A^{0.56(A^{-0.03})} \times P_R^{0.81} \times G_f \quad 356.4 \text{ cfs}
\]

\[
P_{10} = 13.8 \times A^{0.55(A^{-0.03})} \times P_R^{0.9} \times G_f \quad 569.6 \text{ cfs}
\]

\[
P_{25} = 19.4 \times A^{0.53(A^{-0.03})} \times P_R^{0.98} \times G_f \quad 933.9 \text{ cfs}
\]

\[
P_{50} = 24.2 \times A^{0.52(A^{-0.03})} \times P_R^{1.02} \times G_f \quad 1,258.2 \text{ cfs}
\]

\[
P_{100} = 30.1 \times A^{0.51(A^{-0.03})} \times P_R^{1.05} \times G_f \quad 1,647.3 \text{ cfs}
\]

\[
Q_a = 0.0021 \times A^{0.88} \times P_R^{1.19} \quad 375.2 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

- Subtotal (Drainage Yield) 372.6 acre ft

### Reservoir Information

- Reservoir Capacity 15 acre ft
- Sediment Yield (over 20 yrs) 15.7 acre ft
- Seepage acre ft
- Evaporation 0.0 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>15</td>
<td>15</td>
<td>15.0</td>
<td>15.0</td>
<td>15.0</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.8</td>
<td>3.9</td>
<td>7.9</td>
<td>11.8</td>
<td>15.7</td>
</tr>
<tr>
<td><strong>Subtotal (Reservoir Yield)</strong></td>
<td>14.2</td>
<td>11.1</td>
<td>7.1</td>
<td>3.2</td>
<td>0.0</td>
</tr>
<tr>
<td>Livestock (18 gal/AU/day)</td>
<td>8,576.7</td>
<td>6,680.1</td>
<td>4,309.3</td>
<td>1,938.6</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Availabtility in AUMs

<table>
<thead>
<tr>
<th>Livestock Availability in AUMs</th>
</tr>
</thead>
<tbody>
<tr>
<td>8,576.7</td>
</tr>
</tbody>
</table>

*USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.

Little Snake River - Dixon 34
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_J</th>
<th>Net Evaporation Capacity Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.1</td>
<td>11</td>
<td>300.0</td>
<td>7.1</td>
<td>1.0</td>
<td>20.1</td>
<td>40.2</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.59(A^-0.03)} \times P_R^{0.6} \times G_f \]

P_2 = 148.3 cfs

\[ P_3 = 10.6 \times A^{0.56(A^-0.03)} \times P_R^{0.81} \times G_f \]

P_3 = 358.9 cfs

\[ P_{10} = 13.8 \times A^{0.55(A^-0.03)} \times P_R^{0.9} \times G_f \]

P_{10} = 563.6 cfs

\[ P_{25} = 19.4 \times A^{0.53(A^-0.03)} \times P_R^{0.98} \times G_f \]

P_{25} = 907.2 cfs

\[ P_{50} = 24.2 \times A^{0.52(A^-0.03)} \times P_R^{1.02} \times G_f \]

P_{50} = 1,210.9 cfs

\[ P_{100} = 30.1 \times A^{0.51(A^-0.03)} \times P_R^{1.05} \times G_f \]

P_{100} = 1,573.5 cfs

\[ Q_d = 0.0021 \times A^{0.88} \times P_R^{1.19} \]

Q_d = 402.0 acre ft

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 395.0 acre ft

Reservoir Information

Reservoir Capacity 40.2 acre ft

Sediment Yield (over 20 yrs)* 21.3 acre ft

Seepage acre ft

Evaporation 0.0 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>40.2</td>
<td>40.2</td>
<td>40.2</td>
<td>40.2</td>
<td>40.2</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>1.1</td>
<td>5.3</td>
<td>10.7</td>
<td>16.0</td>
<td>21.3</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 39.1 34.9 29.5 24.2 18.9 acre ft

Livestock (18 gal/AU/day) 23613.3 21041.8 17827.5 14613.2 11398.9

Availability in AUM's

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.6</td>
<td>15</td>
<td>200.0</td>
<td>2.8</td>
<td>None</td>
<td>7.0</td>
<td>13.7</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \times A^{0.81} \times P_R^{1.13}
\]

\[
P_5 = 2.36 \times A^{0.79} \times P_R^{0.78}
\]

\[
P_{10} = 5.35 \times A^{0.78} \times P_R^{0.59}
\]

\[
P_{25} = 13.5 \times A^{0.77} \times P_R^{0.38}
\]

\[
P_{50} = 23.8 \times A^{0.77} \times P_R^{0.25}
\]

\[
P_{100} = 40.7 \times A^{0.76} \times P_R^{0.13}
\]

\[
Q_a = 0.013 \times A^{0.93} \times P_R^{1.43}
\]

<table>
<thead>
<tr>
<th>Flood Analysis/Runoff (Lowhan) Mountainous Regions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Subtotal (Drainage Yield)</td>
<td>2,981.2 acre ft</td>
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</table>

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>13.7 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)*</td>
<td>4.9 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>0.0 acre ft</td>
</tr>
</tbody>
</table>

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>13.7</td>
<td>13.7</td>
<td>13.7</td>
<td>13.7</td>
<td>13.7</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.2</td>
<td>1.2</td>
<td>2.4</td>
<td>3.7</td>
<td>4.9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subtotal (Reservoir Yield)</th>
<th>13.5</th>
<th>12.5</th>
<th>11.3</th>
<th>10.0</th>
<th>8.8</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Livestock (18 gal/AU/day)</th>
<th>8,119.0</th>
<th>7,529.5</th>
<th>6,792.6</th>
<th>6,055.6</th>
<th>5,318.7</th>
</tr>
</thead>
</table>

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acre</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>16.2</td>
<td>13</td>
<td>300.0</td>
<td>19.9</td>
<td>1.0</td>
<td>53.1</td>
<td>349.8</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) High Desert Region

\[
P_2 = 6.66 \times A^{0.59(A^-0.03)} \times P_R^{0.6} \times G_f\]

140.7 cfs

\[
P_5 = 10.6 \times A^{0.56(A^-0.03)} \times P_R^{0.81} \times G_f\]

355.3 cfs

\[
P_{10} = 13.8 \times A^{0.55(A^-0.03)} \times P_R^{0.9} \times G_f\]

568.0 cfs

\[
P_{25} = 19.4 \times A^{0.53(A^-0.03)} \times P_R^{0.98} \times G_f\]

931.4 cfs

\[
P_{50} = 24.2 \times A^{0.52(A^-0.03)} \times P_R^{1.02} \times G_f\]

1,254.8 cfs

\[
P_{100} = 30.1 \times A^{0.51(A^-0.03)} \times P_R^{1.05} \times G_f\]

1,642.9 cfs

\[
Q_f = 0.0021 \times A^{0.88} \times P_R^{1.19}\]

373.2 acre ft

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield)

361.1 acre ft

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>349.8 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)*</td>
<td>15.6 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>53.1 acre ft</td>
</tr>
</tbody>
</table>

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>349.8</td>
<td>349.8</td>
<td>349.8</td>
<td>349.8</td>
<td>349.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.8</td>
<td>3.9</td>
<td>7.8</td>
<td>11.7</td>
<td>15.6</td>
</tr>
<tr>
<td>Evaporation (acre ft)</td>
<td>53.1</td>
<td>53.1</td>
<td>53.1</td>
<td>53.1</td>
<td>53.1</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield)

296.0

292.8

288.9

285.0

281.1

Livestock (18 gal/AU/day) Availability in AUM's

178,573.7

176,688.7

174,332.5

171,976.3

169,620.1

*USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographical Factor (G_r)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>16</td>
<td>100.0</td>
<td>2.0</td>
<td>None</td>
<td>4.8</td>
<td>8.8</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[ P_2 = 0.51 \times A^{0.81} \times P_R^{1.13} \]

\[ P_5 = 2.36 \times A^{0.79} \times P_R^{0.78} \]

\[ P_{10} = 5.35 \times A^{0.78} \times P_R^{0.59} \]

\[ P_{25} = 13.5 \times A^{0.77} \times P_R^{0.38} \]

\[ P_{50} = 23.8 \times A^{0.77} \times P_R^{0.25} \]

\[ P_{100} = 40.7 \times A^{0.76} \times P_R^{0.13} \]

\[ Q_a = 0.013 \times A^{0.93} \times P_R^{1.43} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 1,162.2 acre ft

Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>8.8 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)</td>
<td>2.3 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>4.8 acre ft</td>
</tr>
</tbody>
</table>

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
<td>8.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.6</td>
<td>1.1</td>
<td>1.7</td>
<td>2.3</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 8.7 8.2 7.7 7.1 6.5

Livestock (18 gal/AU/day) Availability in AUM’s

| 2,324.2 | 2,047.1 | 1,700.8 | 1,354.5 | 1,008.2 |

Little Snake River - Ketchum Buttes 1 4 WWDC Level II
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_r)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0</td>
<td>17</td>
<td>20.0</td>
<td>5.4</td>
<td>None</td>
<td>12.6</td>
<td>25.6</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \cdot A^{0.81} \cdot P_R^{1.13} = 30.5 \text{ cfs}
\]

\[
P_5 = 2.36 \cdot A^{0.79} \cdot P_R^{0.78} = 51.2 \text{ cfs}
\]

\[
P_{10} = 5.35 \cdot A^{0.78} \cdot P_R^{0.59} = 67.1 \text{ cfs}
\]

\[
P_{25} = 13.5 \cdot A^{0.77} \cdot P_R^{0.38} = 92.3 \text{ cfs}
\]

\[
P_{50} = 23.8 \cdot A^{0.77} \cdot P_R^{0.25} = 112.6 \text{ cfs}
\]

\[
P_{100} = 40.7 \cdot A^{0.76} \cdot P_R^{0.13} = 135.6 \text{ cfs}
\]

\[
Q_a = 0.013 \cdot A^{0.93} \cdot P_R^{1.43} = 1,502.9 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

**Subtotal (Drainage Yield)**

1,492.9 acre ft

### Reservoir Information

- Reservoir Capacity: 25.6 acre ft
- Sediment Yield (over 20 yrs): 0.55 acre ft
- Seepage: acre ft
- Evaporation: 12.6 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
<td>25.6</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.1</td>
<td>0.3</td>
<td>0.4</td>
<td>0.6</td>
</tr>
</tbody>
</table>

**Subtotal (Reservoir Yield)**

25.6 25.5 25.3 25.2 25.0

Livestock (18 gal/AU/day)

<table>
<thead>
<tr>
<th>Availability in AUM's</th>
<th>7,827.4</th>
<th>7,760.9</th>
<th>7,677.8</th>
<th>7,594.7</th>
<th>7,511.6</th>
</tr>
</thead>
</table>

Little Snake River - Ketchum Buttes 3 4 WWDC Level II
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (Gf)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.7</td>
<td>16</td>
<td>100.0</td>
<td>14.1</td>
<td>None</td>
<td>34.1</td>
<td>81.2</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51A^{0.81}P_R^{1.13} \quad 26.2 \text{ cfs}
\]

\[
P_5 = 2.36A^{0.79}P_R^{0.78} \quad 45.0 \text{ cfs}
\]

\[
P_{10} = 5.35A^{0.78}P_R^{0.59} \quad 59.6 \text{ cfs}
\]

\[
P_{25} = 13.5A^{0.77}P_R^{0.38} \quad 83.2 \text{ cfs}
\]

\[
P_{50} = 23.8A^{0.77}P_R^{0.25} \quad 102.3 \text{ cfs}
\]

\[
P_{100} = 40.7A^{0.76}P_R^{0.13} \quad 124.2 \text{ cfs}
\]

\[
Q_a = 0.013A^{0.93}P_R^{1.43} \quad 1,249.5 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 1,248.3 acre ft

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>81.2 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)</td>
<td>2.48 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>34.1 acre ft</td>
</tr>
</tbody>
</table>

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>81.2</td>
<td>81.2</td>
<td>81.2</td>
<td>81.2</td>
<td>81.2</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.6</td>
<td>1.2</td>
<td>1.9</td>
<td>2.5</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 81.1 80.6 80.0 79.3 78.7

| Livestock (18 gal/AU/day) | 28,359.8 | 28,060.6 | 27,686.6 | 27,312.6 | 26,938.6 |
| Availability in AUM's | 4 | 4 | 4 | 4 | 4 |

Little Snake River - Ketchum Buttes 25

WWDC Level II
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P)&lt;sub&gt;R&lt;/sub&gt; Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G&lt;sub&gt;r&lt;/sub&gt;)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.7</td>
<td></td>
<td>50.0</td>
<td>5.5</td>
<td>None</td>
<td>12.8</td>
<td>19.3</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \times A^{0.81} \times P_R^{1.13} \quad 36.2 \text{ cfs}
\]
\[
P_5 = 2.36 \times A^{0.79} \times P_R^{0.78} \quad 60.5 \text{ cfs}
\]
\[
P_{10} = 5.35 \times A^{0.78} \times P_R^{0.59} \quad 79.0 \text{ cfs}
\]
\[
P_{25} = 13.5 \times A^{0.77} \times P_R^{0.38} \quad 108.5 \text{ cfs}
\]
\[
P_{50} = 23.8 \times A^{0.77} \times P_R^{0.25} \quad 132.3 \text{ cfs}
\]
\[
P_{100} = 40.7 \times A^{0.76} \times P_R^{0.13} \quad 159.0 \text{ cfs}
\]
\[
Q_a = 0.013 \times A^{0.93} \times P_R^{1.43} \quad 1,826.6 \text{ acre ft}
\]

**Existing Reservoirs & Senior Appropriators**

**Subtotal (Drainage Yield)** 1,820.5 acre ft

### Reservoir Information

- Reservoir Capacity 19.3 acre ft
- Sediment Yield (over 20 yrs) 1.7 acre ft
- Seepage acre ft
- Evaporation 12.8 acre ft

### Water Use

<table>
<thead>
<tr>
<th></th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>19.3</td>
<td>19.3</td>
<td>19.3</td>
<td>19.3</td>
<td>19.3</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.4</td>
<td>0.8</td>
<td>1.3</td>
<td>1.7</td>
</tr>
</tbody>
</table>

**Subtotal (Reservoir Yield)** 19.2 19.9 18.5 18.0 17.6

- Livestock (18 gal/AU/day) 3,850.6 3,645.6 3,389.4 3,133.1 2,876.9
- Availability in AUM's
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>18</td>
<td>20.0</td>
<td>1.5</td>
<td>None</td>
<td>3.4</td>
<td>8.0</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 * A^{0.81} * P_R^{1.13}
\]

18.6 cfs

\[
P_5 = 2.36 * A^{0.79} * P_R^{0.78}
\]

31.0 cfs

\[
P_{10} = 5.35 * A^{0.78} * P_R^{0.59}
\]

40.4 cfs

\[
P_{25} = 13.5 * A^{0.77} * P_R^{0.38}
\]

55.3 cfs

\[
P_{50} = 23.8 * A^{0.77} * P_R^{0.25}
\]

67.0 cfs

\[
P_{100} = 40.7 * A^{0.76} * P_R^{0.13}
\]

80.7 cfs

\[
Q_a = 0.013 * A^{0.93} * P_R^{1.43}
\]

856.0 acre ft

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 856.0 acre ft

### Reservoir Information

- Reservoir Capacity: 8 acre ft
- Sediment Yield (over 20 yrs): 0.28 acre ft
- Seepage: acre ft
- Evaporation: 3.4 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>8</td>
<td>8</td>
<td>8.0</td>
<td>8.0</td>
<td>8.0</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 8.0

| Livestock (18 gal/AU/day)          | 2,782.4 | 2,749.1 | 2,707.6 | 2,666.0 | 2,624.4 |
| Availability in AUM’s              |         |         |         |         |         |
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographical Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>21.7</td>
<td>12</td>
<td>500.0</td>
<td>4.6</td>
<td>1.0</td>
<td>12.6</td>
<td>36.9</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowihan) High Desert Region

- \( P_2 = 6.66 \times A^0.59(A^-0.03) \times P_R^{0.6} \times G_f \) = 154.9 cfs
- \( P_5 = 10.6 \times A^{0.56(A^-0.03)} \times P_R^{0.81} \times G_f \) = 381.8 cfs
- \( P_{10} = 13.8 \times A^{0.52(A^-0.03)} \times P_R^{0.9} \times G_f \) = 604.5 cfs
- \( P_{25} = 19.4 \times A^{0.53(A^-0.03)} \times P_R^{0.98} \times G_f \) = 980.1 cfs
- \( P_{50} = 24.2 \times A^{0.52(A^-0.03)} \times P_R^{1.02} \times G_f \) = 1,313.0 cfs
- \( P_{100} = 30.1 \times A^{0.51(A^-0.03)} \times P_R^{1.05} \times G_f \) = 1,710.8 cfs
- \( Q_a = 0.0021 \times A^{0.88} \times P_R^{1.19} \) = 438.8 acre ft

### Existing Reservoirs & Senior Appropriators

- Subtotal (Drainage Yield) = 409.5 acre ft

### Reservoir Information

- Reservoir Capacity = 59.2 acre ft
- Sediment Yield (over 20 yrs)* = 34.9 acre ft
- Seepage = acre ft
- Evaporation = 0.0 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity (acre ft)</td>
<td>36.9</td>
<td>36.9</td>
<td>36.9</td>
<td>36.9</td>
<td>36.9</td>
</tr>
<tr>
<td>Sediment Yield (acre ft)</td>
<td>1.7</td>
<td>8.7</td>
<td>17.4</td>
<td>26.2</td>
<td>34.9</td>
</tr>
<tr>
<td>Subtotal (Reservoir Yield)</td>
<td>35.2</td>
<td>28.2</td>
<td>19.5</td>
<td>10.7</td>
<td>2.0</td>
</tr>
<tr>
<td>Livestock (18 gal/AU/day)</td>
<td>34668.4</td>
<td>30460.3</td>
<td>25200.0</td>
<td>19939.8</td>
<td>14679.5</td>
</tr>
</tbody>
</table>

### Availability in AUM's

*USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>11</td>
<td>400.0</td>
<td>88.6</td>
<td>1.0</td>
<td>252.0</td>
<td>1,189.0</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 \times A^{0.59(A^-0.03)} \times P^{0.6} \times G_f \]
\[ P_5 = 10.6 \times A^{0.56(A^-0.03)} \times P^{0.81} \times G_f \]
\[ P_{10} = 13.8 \times A^{0.55(A^-0.03)} \times P^{0.9} \times G_f \]
\[ P_{25} = 19.4 \times A^{0.53(A^-0.03)} \times P^{0.98} \times G_f \]
\[ P_{50} = 24.2 \times A^{0.52(A^-0.03)} \times P^{1.02} \times G_f \]
\[ P_{100} = 30.1 \times A^{0.51(A^-0.03)} \times P^{1.05} \times G_f \]
\[ Q_a = 0.0021 \times A^{0.88} \times P^{1.19} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 484.1 acre ft

Reservoir Information

Reservoir Capacity 1189 acre ft
Sediment Yield (over 20 yrs)* 38.567 acre ft
Seepage acre ft
Evaporation 244.0 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity (acre ft)**</td>
<td>484</td>
<td>484</td>
<td>484.0</td>
<td>484.0</td>
<td>484.0</td>
</tr>
<tr>
<td>Sediment Yield (acre ft)</td>
<td>1.9</td>
<td>9.6</td>
<td>19.3</td>
<td>28.9</td>
<td>38.6</td>
</tr>
<tr>
<td>Evaporation</td>
<td>252.0</td>
<td>252.0</td>
<td>252.0</td>
<td>252.0</td>
<td>252.0</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 230.0 222.0 213.0 203.0 194.0

Livestock (18 gal/AU/day) Availability in AUMs

| Livestock Availability in AUMs | 11514.6 | 4475.1 | 0.0     | 0.0     | 0.0      |

* USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
**Limited by annual drainage yield
### HYDRAULIC ANALYSIS

#### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.0</td>
<td>18</td>
<td>20.0</td>
<td>7.7</td>
<td>None</td>
<td>17.3</td>
<td>55.8</td>
</tr>
</tbody>
</table>

#### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51A^{0.81}P_R^{1.13} \quad \text{23.4 cfs}
\]

\[
P_5 = 2.36A^{0.79}P_R^{0.78} \quad \text{38.9 cfs}
\]

\[
P_{10} = 5.35A^{0.78}P_R^{0.59} \quad \text{50.6 cfs}
\]

\[
P_{25} = 13.5A^{0.77}P_R^{0.38} \quad \text{69.0 cfs}
\]

\[
P_{50} = 23.8A^{0.77}P_R^{0.25} \quad \text{83.6 cfs}
\]

\[
P_{100} = 40.7A^{0.76}P_R^{0.13} \quad \text{100.4 cfs}
\]

\[
Q_a = 0.013A^{0.93}P_R^{1.43} \quad \text{1,118.6 acre ft}
\]

Existing Reservoirs & Senior Appropriators

| Subtotal (Drainage Yield) | 1,118.6 acre ft |

### Reservoir Information

- **Reservoir Capacity**: 55.8 acre ft
- **Sediment Yield (over 20 yrs)**: 0.37 acre ft
- **Seepage**: acre ft
- **Evaporation**: 17.3 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>55.8</td>
<td>55.8</td>
<td>55.8</td>
<td>55.8</td>
<td>55.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Subtotal (Reservoir Yield)</strong></td>
<td>55.8</td>
<td>55.7</td>
<td>55.6</td>
<td>55.5</td>
<td>55.4</td>
</tr>
<tr>
<td>Livestock (18 gal/AU/day)</td>
<td>23,204.2</td>
<td>23,159.9</td>
<td>23,104.5</td>
<td>23,049.1</td>
<td>22,993.7</td>
</tr>
<tr>
<td>Availability in AUM’s</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# HYDRAULIC ANALYSIS

## Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_r)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>16</td>
<td>50.0</td>
<td>1.3</td>
<td>None</td>
<td>3.1</td>
<td>5.0</td>
</tr>
</tbody>
</table>

## Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[ P_2 = 0.51 * A^{0.81} * P_{R}^{1.13} \]
\[ P_5 = 2.36 * A^{0.79} * P_{R}^{0.78} \]
\[ P_{10} = 5.35 * A^{0.78} * P_{R}^{0.59} \]
\[ P_{25} = 13.5 * A^{0.77} * P_{R}^{0.38} \]
\[ P_{50} = 23.8 * A^{0.77} * P_{R}^{0.25} \]
\[ P_{100} = 40.7 * A^{0.76} * P_{R}^{0.13} \]
\[ Q_a = 0.013 * A^{0.93} * P_{R}^{1.43} \]

Subtotal (Drainage Yield) 1,420.8 acre ft

## Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>5 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)</td>
<td>1.42 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>3.1 acre ft</td>
</tr>
</tbody>
</table>

## Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>5</td>
<td>5</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.4</td>
<td>0.7</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td>Seepage</td>
<td>Subtotal (Reservoir Yield)</td>
<td>4.9</td>
<td>4.6</td>
<td>4.3</td>
<td>3.9</td>
</tr>
<tr>
<td>Livestock (18 gal/AU/day)</td>
<td>1,078.4</td>
<td>906.6</td>
<td>691.9</td>
<td>477.2</td>
<td>262.5</td>
</tr>
<tr>
<td>Availability in AUM's</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Little Snake River - Pole Gulch 22

WWDC Level II
## Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Reservoir Capacity</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>16</td>
<td>50.0</td>
<td>0.7</td>
<td>None</td>
<td>1.7</td>
<td>4.0</td>
</tr>
</tbody>
</table>

## Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \times A^{0.81} \times P_R^{1.13} = 10.7 \text{ cfs}
\]

\[
P_5 = 2.36 \times A^{0.79} \times P_R^{0.78} = 18.9 \text{ cfs}
\]

\[
P_{10} = 5.35 \times A^{0.78} \times P_R^{0.59} = 25.3 \text{ cfs}
\]

\[
P_{25} = 13.5 \times A^{0.77} \times P_R^{0.38} = 35.7 \text{ cfs}
\]

\[
P_{50} = 23.8 \times A^{0.77} \times P_R^{0.25} = 43.9 \text{ cfs}
\]

\[
P_{100} = 40.7 \times A^{0.76} \times P_R^{0.13} = 53.9 \text{ cfs}
\]

\[
Q_a = 0.013 \times A^{0.93} \times P_R^{1.43} = 449.8 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

### Subtotal (Drainage Yield)

449.8 acre ft

## Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>4 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)</td>
<td>0.41 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>1.7 acre ft</td>
</tr>
</tbody>
</table>

## Water Use

### 1 Year 5 Years 10 Years 15 years 20 Years

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>4</th>
<th>4</th>
<th>4.0</th>
<th>4.0</th>
<th>4.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.1</td>
<td>0.2</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Seepage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Subtotal (Reservoir Yield)

| 4.0 | 3.4 | 3.8 | 3.7 | 3.6 |

| Livestock (18 gal/AU/day) | 1,380.4 | 1,330.5 | 1,268.2 | 1,205.8 | 1,143.5 |

Availability in AUM's
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A)</th>
<th>Annual Precipitation (P&lt;sub&gt;i&lt;/sub&gt;)</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G&lt;sub&gt;f&lt;/sub&gt;)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>60.5 Sq.Mi.</td>
<td>10</td>
<td>300.0</td>
<td>52.2</td>
<td>0.8</td>
<td>152.3</td>
<td>325.0</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) High Desert Region

\[
P_2 = 6.66 \cdot A^{0.59(A^{-0.03})} \cdot P_{R}^{0.6} \cdot G_f
\]

\[
P_5 = 10.6 \cdot A^{0.56(A^{-0.03})} \cdot P_{R}^{0.81} \cdot G_f
\]

\[
P_{10} = 13.8 \cdot A^{0.55(A^{-0.03})} \cdot P_{R}^{0.9} \cdot G_f
\]

\[
P_{25} = 19.4 \cdot A^{0.53(A^{-0.03})} \cdot P_{R}^{0.98} \cdot G_f
\]

\[
P_{50} = 24.2 \cdot A^{0.52(A^{-0.03})} \cdot P_{R}^{1.02} \cdot G_f
\]

\[
P_{100} = 30.1 \cdot A^{0.51(A^{-0.03})} \cdot P_{R}^{1.05} \cdot G_f
\]

\[
Q_s = 0.0021 \cdot A^{0.88} \cdot P_{R}^{1.19}
\]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 858.4 acre ft

### Reservoir Information

- Reservoir Capacity 325 acre ft
- Sediment Yield (over 20 yrs)* 58.3 acre ft
- Seepage acre ft
- Evaporation 152.3 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity (acre ft)</td>
<td>325.0</td>
<td>325.0</td>
<td>325.0</td>
<td>325.0</td>
<td>325.0</td>
</tr>
<tr>
<td>Sediment Yield (acre ft)</td>
<td>2.9</td>
<td>14.6</td>
<td>29.2</td>
<td>43.8</td>
<td>58.3</td>
</tr>
<tr>
<td>Evaporation (acre ft)</td>
<td>152.0</td>
<td>152.0</td>
<td>152.0</td>
<td>152.0</td>
<td>152.0</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 170.1

| Livestock (18 gal/AU/day) | 102,626.0 | 95,586.5 | 86,787.1 | 77,987.7 | 69,188.3 |

**Availability in AUMs**

*USGS regression estimates reduced by 65 percent based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_a) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.6</td>
<td>14</td>
<td>100.0</td>
<td>2.6</td>
<td>1.0</td>
<td>6.7</td>
<td>11.3</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[ P_2 = 6.66 * A^{0.59(A\-0.03)} * P_R^{0.6} * G_f \]

\[ P_5 = 10.6 * A^{0.56(A\-0.03)} * P_R^{0.81} * G_f \]

\[ P_{10} = 13.8 * A^{0.55(A\-0.03)} * P_R^{0.9} * G_f \]

\[ P_{25} = 19.4 * A^{0.53(A\-0.03)} * P_R^{0.98} * G_f \]

\[ P_{50} = 24.2 * A^{0.52(A\-0.03)} * P_R^{1.02} * G_f \]

\[ P_{100} = 30.1 * A^{0.51(A\-0.03)} * P_R^{1.05} * G_f \]

\[ Q_a = 0.0021 * A^{0.88} * P_R^{1.19} \]

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 134.6 acre ft

Reservoir Information

Reservoir Capacity 11.3 acre ft

Sediment Yield (over 20 yrs) 4.22 acre ft

Seepage acre ft

Evaporation 6.7 acre ft

Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>11.3</td>
<td>11.3</td>
<td>11.3</td>
<td>11.3</td>
<td>11.3</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.2</td>
<td>1.1</td>
<td>2.1</td>
<td>3.2</td>
<td>4.2</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 11.1 10.2 9.2 8.1 7.1

Livestock (18 gal/AU/day) Availability in AUM’s

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>2,638.1</td>
<td>2,128.3</td>
<td>1,491.2</td>
<td>854.0</td>
<td>216.8</td>
</tr>
</tbody>
</table>

Little Snake River - Savery 4

WWDC Level II
HYDRAULIC ANALYSIS

Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>13</td>
<td>200.0</td>
<td>0.5</td>
<td>1.0</td>
<td>1.3</td>
<td>3.2</td>
</tr>
</tbody>
</table>

Flood Analysis/Runoff (Lowhan) High Desert Region

\[
P_2 = 6.66 \times A^{0.59(A^n-0.03)} \times P_{R}^{0.6} \times G_f 
\]

25.1 cfs

\[
P_5 = 10.6 \times A^{0.56(A^n-0.03)} \times P_{R}^{0.81} \times G_f 
\]

69.2 cfs

\[
P_{10} = 13.8 \times A^{0.55(A^n-0.03)} \times P_{R}^{0.9} \times G_f 
\]

113.8 cfs

\[
P_{25} = 19.4 \times A^{0.53(A^n-0.03)} \times P_{R}^{0.98} \times G_f 
\]

197.9 cfs

\[
P_{50} = 24.2 \times A^{0.52(A^n-0.03)} \times P_{R}^{1.02} \times G_f 
\]

274.6 cfs

\[
P_{100} = 30.1 \times A^{0.51(A^n-0.03)} \times P_{R}^{1.05} \times G_f 
\]

370.1 cfs

\[
Q_d = 0.0021 \times A^{0.88} \times P_{R}^{1.19} 
\]

23.5 acre ft

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 23.5 acre ft

Reservoir Information

Reservoir Capacity 3.2 acre ft

Sediment Yield (over 20 yrs) 1.29 acre ft

Seepage acre ft

Evaporation 1.3 acre ft

Water Use 1 Year 5 Years 10 Years 15 years 20 Years

Reservoir Capacity 3.2 3.2 3.2 3.2 3.2

Sediment Yield 0.1 0.3 0.6 1.0 1.3

Subtotal (Reservoir Yield) 3.1 2.9 2.6 2.2 1.9

Livestock (18 gal/AU/day) Availability in AUMs

1,870 1,749 1,568 1,327 1,146

Little Snake River - Savery 8
### HYDRAULIC ANALYSIS

#### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9</td>
<td>13</td>
<td>300.0</td>
<td>8.7</td>
<td>1.0</td>
<td>23.2</td>
<td>39.3</td>
</tr>
</tbody>
</table>

#### Flood Analysis/Runoff (Lowhan) High Desert Region

- \( P_2 = 6.66 \times A^{0.59(A^-0.03) \times P_R^{0.6} \times G_f} \)
  
- \( P_5 = 10.6 \times A^{0.56(A^-0.03) \times P_R^{0.81} \times G_f} \)
  
- \( P_{10} = 13.8 \times A^{0.55(A^-0.03) \times P_R^{0.9} \times G_f} \)
  
- \( P_{25} = 19.4 \times A^{0.53(A^-0.03) \times P_R^{0.98} \times G_f} \)
  
- \( P_{50} = 24.2 \times A^{0.52(A^-0.03) \times P_R^{1.02} \times G_f} \)
  
- \( P_{100} = 30.1 \times A^{0.51(A^-0.03) \times P_R^{1.05} \times G_f} \)

- \( Q_a = 0.0021 \times A^{0.88 \times P_R^{1.19}} \)

#### Reservoir Information

- Reservoir Capacity: 39.3 acre ft
- Sediment Yield (over 20 yrs): 2.48 acre ft
- Seepage: acre ft
- Evaporation: 23.2 acre ft

#### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>39.3</td>
<td>39.3</td>
<td>39.3</td>
<td>39.3</td>
<td>39.3</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.1</td>
<td>0.6</td>
<td>1.2</td>
<td>1.9</td>
<td>2.5</td>
</tr>
</tbody>
</table>

- Subtotal (Reservoir Yield): 39.2 38.7 38.1 37.4 36.8

- Livestock (18 gal/AU/day): 9,639.7 9,340.5 8,966.5 8,592.5 8,218.5

- Availability in AUM’s
### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_s) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_r)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.3</td>
<td>13</td>
<td>300.0</td>
<td>3.7</td>
<td>None</td>
<td>9.9</td>
<td>12.8</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[ P_2 = 0.51A^{0.81}P_r^{1.13} \]
\[ P_5 = 2.36A^{0.79}P_r^{0.78} \]
\[ P_{10} = 5.35A^{0.78}P_r^{0.59} \]
\[ P_{25} = 13.5A^{0.77}P_r^{0.38} \]
\[ P_{50} = 23.8A^{0.77}P_r^{0.25} \]
\[ P_{100} = 40.7A^{0.76}P_r^{0.13} \]
\[ Q_a = 0.013A^{0.93}P_r^{1.43} \]

\[ P_2 = 41.1 \text{ cfs} \]
\[ P_5 = 74.7 \text{ cfs} \]
\[ P_{10} = 102.1 \text{ cfs} \]
\[ P_{25} = 147.6 \text{ cfs} \]
\[ P_{50} = 186.4 \text{ cfs} \]
\[ P_{100} = 230.1 \text{ cfs} \]
\[ Q_a = 2,041.7 \text{ acre ft} \]

Existing Reservoirs & Senior Appropriators

**Subtotal (Drainage Yield)** 2,041.7 acre ft

### Reservoir Information

- Reservoir Capacity 12.8 acre ft
- Sediment Yield (over 20 yrs)* 6.1 acre ft
- Seepage acre ft
- Evaporation 9.9 acre ft

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>12.8</td>
<td>12.8</td>
<td>12.8</td>
<td>12.8</td>
<td>12.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.3</td>
<td>1.5</td>
<td>3.0</td>
<td>4.6</td>
<td>6.1</td>
</tr>
<tr>
<td><strong>Subtotal (Reservoir Yield)</strong></td>
<td>12.5</td>
<td>11.3</td>
<td>9.8</td>
<td>8.2</td>
<td>6.7</td>
</tr>
<tr>
<td>Livestock (18 gal/AU/day)</td>
<td>1,246</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

*USGS estimates reduced by 65% based on MUSLE analysis of selected sites with drainage areas greater than 6 square miles.
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A)</th>
<th>Annual Precipitation (P_A)</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 Sq.Mi.</td>
<td>13</td>
<td>300.0</td>
<td>8.9</td>
<td>None</td>
<td>23.7</td>
<td>97.5</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 * A^{0.81} * P_R^{1.13} \quad 28.4 \text{ cfs}
\]
\[
P_5 = 2.36 * A^{0.79} * P_R^{0.78} \quad 52.2 \text{ cfs}
\]
\[
P_{10} = 5.35 * A^{0.78} * P_R^{0.59} \quad 71.6 \text{ cfs}
\]
\[
P_{25} = 13.5 * A^{0.77} * P_R^{0.38} \quad 104.0 \text{ cfs}
\]
\[
P_{50} = 23.8 * A^{0.77} * P_R^{0.25} \quad 131.4 \text{ cfs}
\]
\[
P_{100} = 40.7 * A^{0.76} * P_R^{0.13} \quad 162.9 \text{ cfs}
\]
\[
Q_4 = 0.013 * A^{0.93} * P_R^{1.43} \quad 1,338.2 \text{ acre ft}
\]

Existing Reservoirs & Senior Appropriators

**Subtotal (Drainage Yield)** 1,338.2 \text{ acre ft}

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>Sediment Yield (over 20 yrs)</th>
<th>Seepage</th>
<th>Evaporation</th>
</tr>
</thead>
<tbody>
<tr>
<td>97.5 \text{ acre ft}</td>
<td>11 \text{ acre ft}</td>
<td>\text{acre ft}</td>
<td>23.7 \text{acre ft}</td>
</tr>
</tbody>
</table>

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>97.5</td>
<td>97.5</td>
<td>97.5</td>
<td>97.5</td>
<td>97.5</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.6</td>
<td>2.8</td>
<td>5.5</td>
<td>8.3</td>
<td>11.0</td>
</tr>
</tbody>
</table>

**Subtotal (Reservoir Yield)** 96.9 | 94.7 | 92.0 | 89.2 | 86.5 |

| Livestock (18 gal/AU/day) | 44,177.4 | 42,847.6 | 41,185.4 | 39,523.2 | 37,860.9 |
| Availability in AUM's | | | | | |
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P&lt;sub&gt;r&lt;/sub&gt;) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G&lt;sub&gt;r&lt;/sub&gt;)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.6</td>
<td>16</td>
<td>20.0</td>
<td>0.9</td>
<td>None</td>
<td>2.2</td>
<td>9.8</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
\begin{align*}
P_2 &= 0.51A^{0.81}P_r^{1.13} & \quad 7.7 \text{ cfs} \\
P_5 &= 2.36A^{0.79}P_r^{0.78} & \quad 13.7 \text{ cfs} \\
P_{10} &= 5.35A^{0.78}P_r^{0.59} & \quad 18.4 \text{ cfs} \\
P_{25} &= 13.5A^{0.77}P_r^{0.38} & \quad 26.1 \text{ cfs} \\
P_{50} &= 23.8A^{0.77}P_r^{0.25} & \quad 32.1 \text{ cfs} \\
P_{100} &= 40.7A^{0.76}P_r^{0.13} & \quad 39.6 \text{ cfs} \\
Q_a &= 0.013A^{0.93}P_r^{1.43} & \quad 308.5 \text{ acre ft} \\
\end{align*}
\]

Existing Reservoirs & Senior Appropriators

*Subtotal (Drainage Yield) 308.5 acre ft*

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>9.8 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)</td>
<td>0.11 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>2.2 acre ft</td>
</tr>
</tbody>
</table>

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 Years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
<td>9.8</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

*Subtotal (Reservoir Yield) 9.8 *

| Livestock (18 gal/AU/day) | 4,597.5 | 4,584.2 | 4,567.6 | 4,551.0 | 4,534.3 |
| Availability in AUM's     |         |         |         |         |         |
## HYDRAULIC ANALYSIS

### Site Information

<table>
<thead>
<tr>
<th>Drainage Area (A) Sq.Mi.</th>
<th>Annual Precipitation (P_R) Inches</th>
<th>Annual Sediment Prod. Tons/Sq.Mi./Year</th>
<th>Reservoir Surface Area Acres</th>
<th>Geographic Factor (G_f)</th>
<th>Net Evaporation Acre feet</th>
<th>Reservoir Capacity Acre Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2</td>
<td>16</td>
<td>20.0</td>
<td>1.8</td>
<td>None</td>
<td>4.4</td>
<td>8.1</td>
</tr>
</tbody>
</table>

### Flood Analysis/Runoff (Lowhan) Mountainous Regions

\[
P_2 = 0.51 \cdot A^{0.81} \cdot P_R^{1.13}
\]

13.6 cfs

\[
P_5 = 2.36 \cdot A^{0.79} \cdot P_R^{0.78}
\]

23.7 cfs

\[
P_{10} = 5.35 \cdot A^{0.78} \cdot P_R^{0.59}
\]

31.7 cfs

\[
P_{25} = 13.5 \cdot A^{0.77} \cdot P_R^{0.38}
\]

44.6 cfs

\[
P_{50} = 23.8 \cdot A^{0.77} \cdot P_R^{0.25}
\]

54.8 cfs

\[
P_{100} = 40.7 \cdot A^{0.76} \cdot P_R^{0.13}
\]

67.0 cfs

\[
Q_A = 0.013 \cdot A^{0.93} \cdot P_R^{1.43}
\]

587.7 acre ft

Existing Reservoirs & Senior Appropriators

Subtotal (Drainage Yield) 587.7 acre ft

### Reservoir Information

<table>
<thead>
<tr>
<th>Reservoir Capacity</th>
<th>8.1 acre ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sediment Yield (over 20 yrs)</td>
<td>0.22 acre ft</td>
</tr>
<tr>
<td>Seepage</td>
<td>acre ft</td>
</tr>
<tr>
<td>Evaporation</td>
<td>4.4 acre ft</td>
</tr>
</tbody>
</table>

### Water Use

<table>
<thead>
<tr>
<th>Water Use</th>
<th>1 Year</th>
<th>5 Years</th>
<th>10 Years</th>
<th>15 years</th>
<th>20 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Capacity</td>
<td>8.1</td>
<td>8.1</td>
<td>8.1</td>
<td>8.1</td>
<td>8.1</td>
</tr>
<tr>
<td>Sediment Yield</td>
<td>0.0</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Subtotal (Reservoir Yield) 8.1

| Livestock (18 gal/AU/day) Availability in AUMs | 1,086 | 1,025 | 1,025 | 965 | 965 |

Little Snake River - Tullis 30

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WWDC Level II
APPENDIX F

GEOLOGIC/GEOTECHNICAL SUMMARIES
SOIL CONDITIONS

Based on surficial soil conditions observed in the area during the site visit, the surficial soils appear to primarily consist of a brown, silty fine sand. However, there are some areas of a red, sandy clay, likely a residual of a weathered shale. A sample of the brown, silty fine sand was collected from the channel area, and a sample of the red, sandy clay was collected from the proposed right abutment. It appears that the right abutment would primarily consist of sandstone materials, while the left abutment would consist of a weathered shale. Surficial soil mapping indicates that the primary soils within this area are mapped as soils of the Cushool-Rock River Complex (Soil No. 225). The composition of this soil is 50 percent Cushool sandy loams, and 30 percent Rock River sandy loams. Cushool soils are generally a fine grained soil, which exhibit little to no plasticity and are classified as a silty sand (SM). Rock River soils are generally a fine to coarse grained soil, which exhibit medium to no plasticity and are classified as a silty sand to a silty, clayey sand (SM, SC-SM). Embankment limitations are listed as severe due to a thin layer of available materials and the materials are susceptible to piping. The secondary soils in this area are mapped as Baggs silty clay soils (Soil No. 904) and Blackhall-Thermopolis Variant-Rock outcrop complex (Soil No. 920). The Baggs silty clay soils are located approximately 1200 feet north of the proposed embankment. These soils exhibit medium to high plasticity and are classified as a silty clay (CL, CH). It is anticipated that these silty clay soils would make a good embankment material. The soils from the Blackhall-Thermopolis Variant-Rock outcrop complex are located approximately 1,000 feet southeast of the proposed embankment. This soils is comprised of 50 percent of Blackhall sandy loam, 25 percent of Thermopolis Variant clay loam and 15 percent of rock outcrop. The Blackhall soils exhibit little to no plasticity and are classified as a silty sand (SM). The Thermopolis Variant soils exhibit medium to high plasticity and are classified a silty clay to a plastic silt (CL, CH, MH). Material properties are shown below. Geologic mapping shows this area to be mapped as the Cathedral Bluffs Tongue of the Wasatch Formation. The Cathedral Bluffs Tongue is classified as a variegated claystone and lenticular sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Cushool</th>
<th>Rock River</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>sandy loam</td>
<td>sandy clay loam</td>
</tr>
<tr>
<td>USCS:</td>
<td>SM</td>
<td>SM, SC-SM</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-4</td>
<td>A-4</td>
</tr>
<tr>
<td>LL:</td>
<td>---</td>
<td>15-25</td>
</tr>
<tr>
<td>PI:</td>
<td>NP</td>
<td>NP-10</td>
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<tr>
<td>Permeability (in/hr):</td>
<td>2.0-6.0</td>
<td>0.6-2.0</td>
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<tr>
<td>R - 3&quot;:</td>
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<td>0-5</td>
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<tr>
<td>P #4:</td>
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<td>P #40:</td>
<td>50-65</td>
<td>80-90</td>
</tr>
<tr>
<td>P #200:</td>
<td>25-35</td>
<td>35-45</td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

SECONDARY SOILS

Baggs
USDA Texture: silty clay
USCS: CL, CH
AASHTO: A-7
LL: 40-60
PI: 20-40
Permeability (in/hr): <0.6

Blackhall
USDA Texture: sandy loam
USCS: SM
AASHTO: A-2
LL: 0
PI: NP
Permeability (in/hr): 2.0-6.0

Thermopolis Variant
USDA Texture: clay
USCS: CL, CH, MH
AASHTO: A-7
LL: 45-60
PI: 20-25
Permeability (in/hr): 0.06-0.2

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Very Poor
Suitability of Secondary Embankment Soils: Very Good
Availability of Primary Embankment Soils: Poor
Availability of Secondary Embankment Soils: Poor

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
</tr>
</thead>
</table>
SOIL CONDITIONS

Based on the surficial soil conditions observed in the area during the site visit, the surficial soils appear to consist of a light brown, clayey to silty fine sand. A sample collected from the channel area consisted of 3 feet of a light brown, clayey to silty fine sand, over a light brown, sandy clay from 3 to 3.5 feet, and a light brown, clayey, medium grained sand from 3.5 to 4 feet. A sample collected from the right abutment consisted of 3 feet of a light brown, fine sandy clay over a light brown, silty to clayey, fine sand from 3 to 3.5 feet. Surficial soil mapping indicates that the primary soils within this area are mapped as soils of the Dines-Dines overflow complex (Soil No. 449). The composition of these soils are 60 percent Dines silt loam and 30 percent Dines silt loam overflow. The soil properties for the Dines and the Dines overflow are similar and range from a silt loam to a silty clay loam. These soils exhibit medium plasticity and are classified as a low plasticity clay (CL). Embankment limitations within this area are listed as severe due to piping potential, excess salt/sodium and difficulty to compact embankment materials. Possible secondary soils within the area are mapped as Dines silt loam (Soil No. 429) and soils of the Absher-Forelle complex (Soil No. 289). The Dines silt loam soils are similar to the Dines-Dines overflow complex. The composition of the Absher-Forelle complex are 50 percent Absher silty clay and 30 percent Forelle loam. The Dines silt loam soils are located approximately 50 feet east of the proposed embankment and the Absher-Forelle soils are located approximately 200 feet northwest of the proposed embankment. The Absher-Forelle soils are generally considered to consist of a silty clay loam exhibiting medium to high plasticity. Embankment limitations for the secondary soils are listed as slight to severe due to a thin layer of available materials, susceptibility of embankment materials to piping and excess salt/sodium. Material properties are shown below. Geologic mapping shows this area to be mapped as Lewis Shale. Lewis Shale is classified as gray marine shale containing many gray and brown lenticular concretion-rich sandstone beds.

SOIL PROPERTIES

**PRIMARY SOILS**

<table>
<thead>
<tr>
<th>Dines and Dines overflow</th>
<th>USDA Texture:</th>
<th>silty clay loam</th>
<th>USCS:</th>
<th>CL</th>
<th>AASHTO:</th>
<th>A-6</th>
<th>LL:</th>
<th>30-40</th>
<th>PI:</th>
<th>15-20</th>
<th>Permeability (in/hr):</th>
<th>0.2-0.6</th>
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</thead>
<tbody>
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<td>P #4:</td>
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<tr>
<td>P #10:</td>
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<td>P #40:</td>
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<tr>
<td>P #200:</td>
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**SECONDARY SOILS**

<table>
<thead>
<tr>
<th>Absher</th>
<th>USDA Texture:</th>
<th>silty clay/clay loam</th>
<th>USCS:</th>
<th>CL, CH</th>
<th>AASHTO:</th>
<th>A-7</th>
<th>LL:</th>
<th>40-60</th>
<th>PI:</th>
<th>20-40</th>
<th>Permeability (in/hr):</th>
<th>&gt;0.6</th>
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</thead>
</table>
| R - 3":                 |               |                      | P #4: | 95-100 | P #10:  | 75-100 | P #40: | 70-100 | P #200: | 60-95 |}

INBERG-MILLER ENGINEERS
SOIL PROPERTIES, Continued
SECONDARY SOILS, Continued
Forelle
USDA Texture: silty clay loam
USCS: CL
AASHTO: A-6, A-7
LL: 35-45
PI: 15-25
Permeability (in/hr): 0.2-0.6

RANKING CRITERIA

Foundation Suitability: Good
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Good
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Good

| Material Suitability/Availability Rank | 3 |
SOIL CONDITIONS

Surficial soil conditions observed in the area during the site visit consisted of a light brown, silty fine sand. A sample collected from the channel area consisted of the a light brown, silty fine sand to a depth of 3 feet, overlying a brown to gray, sandy clay from 3 to 4 feet. A sample collected from the proposed right abutment consisted of a light brown, silty fine sand with some gravel. However, the abutment sample was only able to be advanced to a depth of 1 foot below ground surface due to rocky conditions. Surficial soil mapping indicates that the proposed embankment lies near the boundary of two soil types, Villy loam (Soil No. 294) and soils of the Seaverson-Blazon complex (Soil No. 237). Villy loam soils exhibit low to medium plasticity and is classified as a silty clay with sand (CL). The Seaverson-Blazon soils consist of a clay loam to loam soils exhibiting low plasticity. Embankment limitations are listed as severe due to wet conditions for the Villy loam soils. Embankment limitations for the Seaverson-Blazon soils are listed as severe due to a thin layer of available materials. Secondary soils mapped within the area of the proposed embankment consist of Ryark loamy sands (Soil No. 297). Ryark loamy sands are located approximately 300 feet northwest of the proposed embankment and consist of sandy loam exhibiting no plasticity. The Ryark loamy sand soils are not anticipated to be suitable for embankment construction. Geologic mapping shows the proposed embankment to be mapped near the boundary of two geologic formations, Lewis Shale and Alluvium and Colluvium deposits. Lewis Shale is classified as gray marine shale containing many gray and brown lenticular concretion-rich sandstone beds. Alluvium and Colluvium deposits consist of clay, silt, sand and gravel.

SOIL PROPERTIES

PRIMARY SOILS

Villy

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<thead>
<tr>
<th>USDA Texture:</th>
<th>silt loam</th>
<th>USCS:</th>
<th>CL</th>
<th>AASHTO:</th>
<th>A-6</th>
<th>LL:</th>
<th>25-35</th>
<th>PI:</th>
<th>10-20</th>
<th>Permeability (in/hr):</th>
<th>0.2-0.6</th>
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</table>

SECONDARY SOILS

Seaverson

<table>
<thead>
<tr>
<th>USDA Texture:</th>
<th>clay loam</th>
<th>USCS:</th>
<th>CL</th>
<th>AASHTO:</th>
<th>A-6</th>
<th>LL:</th>
<th>35-40</th>
<th>PI:</th>
<th>10-20</th>
<th>Permeability (in/hr):</th>
<th>0.2-0.6</th>
</tr>
</thead>
</table>
SOIL PROPERTIES, Continued
SECONDARY SOILS, Continued

Blazon
USDA Texture: loam
USCS: ML, CL-ML
AASHTO: A-4
LL: 25-35
PI: 5-10
Permeability (in/hr): 0.6-2.0

Ryark
USDA Texture: loamy sand
USCS: SM
AASHTO: A-1, A-2
LL: ---
PI: NP
Permeability (in/hr): >6.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Very Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 3 |
SOILS CONDITIONS

The surficial soils observed during the site visit consist of a clay, silt, sand and gravel with numerous boulders and rock outcroppings. This site is similar to the Bridger Pass 12 and Bridger Pass 32 sites. Due to rocky conditions, only one sample was collected from the channel area. This sample consisted of 2 feet of highly organic, silty to clayey sand overlying a grayish brown, sandy clay. These sandy clay soils may suitable for embankment construction. Surficial soil mapping indicates that the primary soils in the embankment area consists of soils of the Rentsac-Adel complex (Soil No. 185). The composition of these soils was not able to be determined. The Rentsac soils consist of a channery loam which exhibit little to no plasticity, and are classified as a silty gravel (GM). The Adel soils consist of a fine loamy soils overlying a heavy clay loam in some areas. Specific soil properties for the Adel soils were not available. Embankment limitations are listed as severe due to a thin layer of available materials and the potential for piping of the embankment soils. Secondary soils in the area consist solely as a Rentsac channery loam (Soil No. 264). Soil properties are similar to the Rentsac portion of the Rentsac-Adel complex. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Rentsac</th>
<th>Adel</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>channery loam</td>
<td>fine loamy</td>
</tr>
<tr>
<td>USCS:</td>
<td>GM</td>
<td>N/A</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-1</td>
<td>N/A</td>
</tr>
<tr>
<td>LL:</td>
<td>---</td>
<td>N/A</td>
</tr>
<tr>
<td>PI:</td>
<td>NP</td>
<td>N/A</td>
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<tr>
<td>Permeability (in/hr):</td>
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<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>R - 3&quot;:</th>
<th>P #4:</th>
<th>P #10:</th>
<th>P #40:</th>
<th>P #200:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rentsac</td>
<td>5-10</td>
<td>50-80</td>
<td>35-75</td>
<td>30-65</td>
<td>22-55</td>
</tr>
<tr>
<td>Adel</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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</table>

INBERG-MILLER ENGINEERS
**BRIDGER PASS 6**

**RANKING CRITERIA**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Foundation Suitability:</td>
<td>Poor</td>
</tr>
<tr>
<td>Suitability of Primary Embankment Soils:</td>
<td>Poor</td>
</tr>
<tr>
<td>Suitability of Secondary Embankment Soils:</td>
<td>Poor</td>
</tr>
<tr>
<td>Availability of Primary Embankment Soils:</td>
<td>Fair</td>
</tr>
<tr>
<td>Availability of Secondary Embankment Soils:</td>
<td>Fair</td>
</tr>
</tbody>
</table>

| Material Suitability/Availability Rank | 2   |

**INBERG-MILLER ENGINEERS**
SOIL CONDITIONS

The surficial soils observed during the site visit consist of alluvial and colluvial deposits of clay, silt, sand and gravel with numerous boulders and rock outcroppings. This area is very similar to the Bridger Pass 6 and Bridge Pass 32 sites. A sample collected for the channel area consisted of 3 feet of highly organic clayey sand overlying a gray, sandy clay to 4 feet. A sample collected from the left abutment area primarily consisted of a brown, silty sand with some gravel. However, auger refusal was met at 1 foot due to rocky conditions. Surficial soil mapping indicates that the primary soils in the embankment area consists of soils of the Rentsac-Adel complex (Soil No. 185). The composition of these soils was not able to be determined. The Rentsac soils consist of a channery loam which exhibit little to no plasticity, and are classified as a silty gravel (GM). The Adel soils consist of a fine loamy soils overlying a heavy clay loam in some areas. Specific soil properties for the Adel soils were not available. Embankment limitations are listed as severe due to a thin layer of available materials and the potential for piping of the embankment soils. Secondary soils in the area are mapped as soils of the Rentsac-Shinbara complex (Soil No. 202). The composition of these soils was not able to be determined. The soil properties of the Rentsac portion of this complex are similar to those of the Rentsac-Adel complex. Shinbara soils are considered to be a gravelly loam exhibiting slight plasticity. The Shinbara soils are classified as a silty, clayey gravel (GC-GM). Soil properties are shown below. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Rentsac</th>
<th>Adel</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>channery loam</td>
<td>fine loamy</td>
</tr>
<tr>
<td>USCS:</td>
<td>GM</td>
<td>N/A</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-1</td>
<td>N/A</td>
</tr>
<tr>
<td>LL:</td>
<td>---</td>
<td>N/A</td>
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<tr>
<td>PI:</td>
<td>NP</td>
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<tr>
<td>Permeability (in/hr):</td>
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</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>R - 3&quot;:</th>
<th>P #4:</th>
<th>P #10:</th>
<th>P #40:</th>
<th>P #200:</th>
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<tbody>
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<td>30-65</td>
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<td>N/A</td>
<td>N/A</td>
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<td>N/A</td>
</tr>
</tbody>
</table>

INBERG-MILLER ENGINEERS
SOIL PROPERTIES, Continued

SECONDARY SOILS

Shinbara

USDA Texture: gravelly loam
USCS: GC-GM, GM
AASHTO: A-4
LL: 25-35
PI: 5-10
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Poor
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Fair

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>2</th>
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</thead>
</table>
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of a silty sand with gravel and numerous boulders and rock outcroppings. This site is similar to the Bridger Pass 6 and Bridger Pass 12 sites. A sample collected from the proposed abutment area consisted of a brown, silty sand with gravel with auger refusal met at 3 feet. The channel sample consisted of 3 feet of highly organic, sandy clay overlying a grayish brown, sandy clay. A very weathered, gray sandstone was encountered at 4 feet. Surficial soil mapping indicates that the primary soils in the embankment area consists of soils of the Rentsac-Adel complex (Soil No. 185). The composition of these soils was not able to be determined. The Rentsac soils consist of a channery loam which exhibit little to no plasticity, and are classified as a silty gravel (GM). The Adel soils consist of a fine loamy soils overlying a heavy clay loam in some areas. Specific soil properties for the Adel soils were not available. Embankment limitations are listed as severe due to a thin layer of available materials and the potential for piping of the embankment soils. Secondary soils in the area consist solely as a Rentsac channery loam (Soil No. 264). Soil properties are similar to the Rentsac portion of the Rentsac-Adel complex. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th></th>
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<td>2.0-6.0</td>
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<tr>
<td>R - 3&quot;:</td>
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<tr>
<td>P #4:</td>
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</tbody>
</table>

INBERG-MILLER ENGINEERS
RANKING CRITERIA

Foundation Suitability: Poor
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Fair

Material Suitability/Availability Rank | 2
LEGEND

SOIL BOUNDARY
RESERVOIR HWL
CONTOUR LINE (20' INTERVAL)
STREAM CHANNEL

PRIMARY

RENTSAC-ADEL COMPLEX
185 RENTSAC CHANNERY LOAM
ADEL LOAM

SECONDARY

264 RENTSAC CHANNERY LOAM
SOIL CONDITIONS

The surficial soils observed in the area during the site visit consisted of gravel, cobbles and boulders in a silty sand matrix. Samples were collected from the channel area and from the proposed abutment area. The samples were consistent with the surficial soils and consisted of gravel, cobbles and boulders in a dark brown, silty sand to clayey sand matrix. Near surface auger refusal was met due to the rocky conditions. Surficial soil mapping indicates that the primary soils in this area are mapped as soils of the Blazon-Shinbara-Rentsac complex (Soil No. 563). The composition of the complex consists of 30 percent of Blazon clay loam, 30 percent of Shinbara loam and 20 percent of Rentsac channery sandy loam. Blazon-Shinbara-Rentsac soils are generally classified as a silty to sandy clay with some gravel. Blazon clay loams are classified as a medium plasticity sandy clay (CL), Shinbara loams are classified as a low plasticity sandy clay to sandy silt (CL, CL-ML) and Renstac loams are classified as silty sand and gravel (GM). Embankment limitations for these primary soils are listed as severe due to a thin layer of available materials. Secondary soils mapped in the area of the proposed embankment consist of Haggerty-Diamondville-Lupinto complex (Soil No. 1460) and soils of the Peyton-Evanston complex (Soil No. 1441). The Haggerty-Diamondville-Lupinto soils are located approximately 50 feet south of the proposed embankment. The Haggerty-Diamondville-Lupinto soils are generally a clay loam soil to a very gravelly, silty clay loam exhibiting medium to high plasticity. Embankment limitations are listed as moderate due to piping and seepage. Soils of the Peyton-Evanston complex are located approximately 300 feet northeast of the proposed embankment. Peyton-Evanston soils are generally a loamy sand to sandy clay soil. Embankment limitations are listed as moderate to severe due to the susceptibility to piping of the embankment materials. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

PRIMARY SOILS

<table>
<thead>
<tr>
<th>Soil Type</th>
<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
<th>Permeability (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blazon</td>
<td>clay loam</td>
<td>CL</td>
<td>A-6</td>
<td>35-40</td>
<td>10-20</td>
<td>0.6-2.0</td>
</tr>
<tr>
<td></td>
<td>R - 3&quot;</td>
<td>P #4</td>
<td>P #10</td>
<td>80-100</td>
<td>75-95</td>
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<tr>
<td>Shinbara</td>
<td>clay loam</td>
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<td>A-6</td>
<td>35-40</td>
<td>10-20</td>
<td>0.2-0.6</td>
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<tr>
<td></td>
<td>R - 3&quot;</td>
<td>P #4</td>
<td>P #10</td>
<td>80-100</td>
<td>75-95</td>
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**BROWNS HILL 10**

**SOIL PROPERTIES, Continued**

**PRIMARY SOILS, Continued**

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<tr>
<th>Location</th>
<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
<th>Permeability (in/hr)</th>
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<tbody>
<tr>
<td>Rentsac</td>
<td>channery sandy loam</td>
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<td>---</td>
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<td><strong>R - 3&quot;:</strong> 10-20</td>
<td><strong>P #4:</strong> 40-60</td>
<td><strong>P #10:</strong> 25-35</td>
<td><strong>P #40:</strong> 15-30</td>
<td><strong>P #200:</strong> 10-25</td>
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<tr>
<td></td>
<td><strong>USCS:</strong> GM</td>
<td><strong>AASHTO:</strong> A-1</td>
<td><strong>LL:</strong> ---</td>
<td><strong>PI:</strong> NP</td>
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<tr>
<td></td>
<td><strong>Permeability (in/hr):</strong> 2.0-6.0</td>
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**SECONDARY SOILS**

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<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
<th>Permeability (in/hr)</th>
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<tbody>
<tr>
<td>Haggerty</td>
<td>loamy</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<td><strong>R - 3&quot;:</strong> N/A</td>
<td><strong>P #4:</strong> N/A</td>
<td><strong>P #10:</strong> N/A</td>
<td><strong>P #40:</strong> N/A</td>
<td><strong>P #200:</strong> N/A</td>
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<tr>
<td>Diamondville</td>
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<td><strong>P #40:</strong> 85-95</td>
<td><strong>P #200:</strong> 85-95</td>
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<td><strong>USCS:</strong> CL</td>
<td><strong>AASHTO:</strong> A-6,A-7</td>
<td><strong>LL:</strong> 15-25</td>
<td><strong>PI:</strong> 5-10</td>
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<td>Lupinto</td>
<td>gravelly silty clay loam</td>
<td>GC-GM</td>
<td>A-2-6</td>
<td>20-40</td>
<td>5-15</td>
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<td><strong>R - 3&quot;:</strong> 10-25</td>
<td><strong>P #4:</strong> 45-65</td>
<td><strong>P #10:</strong> 35-55</td>
<td><strong>P #40:</strong> 20-40</td>
<td><strong>P #200:</strong> 15-30</td>
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<tr>
<td></td>
<td><strong>USCS:</strong> GC-GM</td>
<td><strong>AASHTO:</strong> A-2-6</td>
<td><strong>LL:</strong> 20-40</td>
<td><strong>PI:</strong> 5-15</td>
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<tr>
<td>Peyton</td>
<td>loamy coarse sand</td>
<td>SM</td>
<td>A-1, A-2</td>
<td>---</td>
<td>NP</td>
<td>2.0-6.0</td>
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<tr>
<td></td>
<td><strong>R - 3&quot;:</strong> 0-5</td>
<td><strong>P #4:</strong> 80-100</td>
<td><strong>P #10:</strong> 35-85</td>
<td><strong>P #40:</strong> 20-50</td>
<td><strong>P #200:</strong> 10-35</td>
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<tr>
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<td><strong>USCS:</strong> SM</td>
<td><strong>AASHTO:</strong> A-1, A-2</td>
<td><strong>LL:</strong> ---</td>
<td><strong>PI:</strong> NP</td>
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<td><strong>Permeability (in/hr):</strong> 2.0-6.0</td>
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</table>
BROWNS HILL 10

SOIL PROPERTIES, Continued
SECONDARY SOILS, Continued

Evanston
USDA Texture: clay loam
USCS: CL
AASHTO: A-6
LL: 25-35
PI: 10-15
Permeability (in/hr): 0.6-2.0

RANKING CRITERIA

Foundation Suitability: Poor
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Fair
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Good

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
</tr>
</thead>
</table>

INBERG-MILLER ENGINEERS
LEGEND

- SOIL BOUNDARY
- RESERVOIR HWL
- CONTOUR LINE (20' INTERVAL)
- STREAM CHANNEL

PRIMARY

BLAZON—SHINBARA—RENTSAC COMPLEX
- 563 BLAZON CLAY LOAM
- 30% SHINBARA LOAM
- 20% RENTSAC CHANNERY SANDY LOAM

SECONDARY

HAGGERTY—DIAMONDVILLE—LUPINTO COMPLEX
- 1460 HAGGERTY LOAM
- DIAMONDVILLE LOAM
- LUPINTO LOAM
- PEYTON—EVENSTON COMPLEX
- 1441 PEYTON LOAM
- EVENSTON LOAM
- 1469 HAGGERTY LOAMS

INBERG—MILLER ENGINEERS
1120 E. C STREET CASPER, WYOMING
82601 307-577-0806

LUDSTONE & ANDERSON, INC.
FILE NO: 7725-08
LITTLE SNAKE RIVER BASIN STOCKWATER PONDS
BROWNS HILL NO. 10 RESERVOIR

INERTICAL: 1
DRAWN BY:
DATE: 3-11-98

SCALE: 1’ = 400’
100 200 300 400
SOIL CONDITIONS

The surficial soils observed during the site visit consisted of a silty to clayey sand with some gravel and cobbles. Some sandstone rock outcrops were observed in the area. A sample collected from the proposed abutment area consists of 1 foot of a brown, silty sand overlying 2 feet of a dark brown, clayey sand. A sample from the channel area consisted of a dark brown, clayey sand. Auger refusal was met at 3 feet in the abutment sample and at 1 foot in the channel sample due to rocky conditions. Surficial soil mapping indicates that the primary soils in the embankment area border between soils of the Evanston-Diamondville-Zillion complex (Soil No. 1481) and soils of the Haggerty-Diamondville-Lupinto complex (Soil No. 1460). Evanston soils are a clay loam soil exhibiting medium plasticity, Diamondville soils are a clay loam soil exhibiting medium to high plasticity and Zillion soils are a gravelly sandy loam exhibiting slight to no plasticity. Haggerty soils are a loamy soils and Lupinto soils are a very gravelly, silty clay loam exhibiting medium to high plasticity. Embankment limitations are listed as moderate due to piping and seepage. Secondary soils mapped within the area consist of soils of the Peyton-Evanston complex (Soil No. 1441) and Pagoda loams. These Peyton-Evanston soils are located approximately 1,200 feet north of the proposed embankment location and the Pagoda loams are located approximately 1000 feet west of the proposed embankment. No soil properties are available for Pagoda loams, however, for soil properties for Peyton-Evanston complex see the summary for the Brown Hill 10 site. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evanson</td>
</tr>
<tr>
<td>USDA Texture: clay loam</td>
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<tr>
<td>USCS: CL</td>
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<tr>
<td>AASHTO: A-6</td>
</tr>
<tr>
<td>LL: 25-35</td>
</tr>
<tr>
<td>PI: 10-15</td>
</tr>
<tr>
<td>Permeability (in/hr): 0.6-2.0</td>
</tr>
</tbody>
</table>

Diamondville

| USDA Texture: clay loam | R - 3": 0-5 |
| USCS: CL | P #4: 95-100 |
| AASHTO: A-6,A-7 | P #10: 95-100 |
| LL: 15-25 | P #40: 85-95 |
| PI: 5-10 | P #200: 85-95 |
| Permeability (in/hr): 0.6-2.0 |
SOIL PROPERTIES, Continued

PRIMARY SOILS, Continued

Zillion
USDA Texture: gravelly sandy loam
USCS: GM
AASHTO: A-1
LL: 20-25
PI: 0-5
Permeability (in/hr): 2.0-6.0

Haggerty
USDA Texture: loamy
USCS: N/A
AASHTO: N/A
LL: N/A
PI: N/A
Permeability (in/hr): N/A

Lupinto
USDA Texture: gravelly silty clay loam
USCS: GC-GM
AASHTO: A-2-6
LL: 20-40
PI: 5-15
Permeability (in/hr): 0.6-2.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Good
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Poor

Material Suitability/Availability Rank 3
SOIL CONDITIONS
The soil condition observed during the site visit consisted of a brown, silty fine sand. Samples collected from the channel and the proposed abutment were generally similar and consisted of a grayish brown, silty fine sand. However, auger refusal was met at 1 foot in both samples. An erosional cut along the creek shows a small amount of clay. Surficial soil mapping indicates that the primary soils within the area of the proposed embankment consist of soils of the Aquepts-Fluvents complex (Soil No. 200). The composition of this complex is 50 percent Aquepts and 40 percent Fluvents. Specific soil properties are not listed for Aquepts and Fluvents because these soils are a highly variable alluvial deposit. Embankment limitations are listed as severe due to excess salt/sodium. Excessive salt/sodium indicates a corrosive environment and indicates a greater susceptibility to piping. Secondary soils in the area are mapped as soils of the Evanston-Diamondville-Zillion complex (Soil No. 1481). These secondary soils are located approximately 100 feet away on each side of the stream channel. Evanston-Diamondville-Zillion soils are generally a clayey loam with gravel and may be suitable for embankment construction. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Aquepts-Fluvents</th>
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<tbody>
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<td>USDA Texture:</td>
<td>highly variable</td>
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<tr>
<td>USCS:</td>
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<tr>
<td>AASHTO:</td>
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<td>LL:</td>
<td>N/A</td>
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<td>PI:</td>
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<tr>
<td>Permeability (in/hr):</td>
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<table>
<thead>
<tr>
<th>SECONDARY SOILS</th>
<th>Evanston</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
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<tr>
<td>USCS:</td>
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<tr>
<td>AASHTO:</td>
<td>A-6</td>
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<td>LL:</td>
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<tr>
<td>PI:</td>
<td>10-15</td>
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<tr>
<td>Permeability (in/hr):</td>
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<tr>
<th>SECONDARY SOILS</th>
<th>Diamondville</th>
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<td>AASHTO:</td>
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</tr>
<tr>
<td>Permeability (in/hr):</td>
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INBERG-MILLER ENGINEERS
SOIL PROPERTIES, Continued
SECONDARY SOILS, Continued

Zillion
USDA Texture: gravelly sandy loam
USCS: GM
AASHTO: A-1
LL: 20-25
PI: 0-5
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Fair
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Good

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
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</thead>
</table>
SOILS CONDITIONS

The surficial soils observed during the site visit consisted of a highly vegetated, brown, silty sand. Samples collected from the channel and the proposed abutment area consist of a brown to dark brown, silty sand. However, auger refusal was met at 1 foot due to rocky conditions. No specific surficial soil mapping was available for this area. However, general soil mapping indicates that these soils in the vicinity of the Medicine Bow National Forest consist of gravelly clay loams. However, there is a large potential for variability of surficial soil conditions. Based on our site visit, we do not anticipate that the surficial soils would be good for embankment construction. Embankment limitations are likely to be severe due to a potentially thin layer of acceptable embankment materials and the silty sand soils are potentially susceptible to piping. Geologic mapping shows the area to be mapped near the boundary line of the Rawlins Uplift of the Mesaverde Group and Miocene Rocks. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

PRIMARY SOILS

<table>
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<tr>
<th>Property</th>
<th>Value</th>
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<td>USCS</td>
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<td>LL:</td>
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<td>PI:</td>
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<tr>
<td>Permeability (in/hr):</td>
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<td>LL:</td>
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RANKING CRITERIA

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<tr>
<td>Availability of Secondary Embankment Soils:</td>
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</table>
LEGEND

- RESERVOIR HWL
- CONTOUR LINE (20' INTERVAL)
- STREAM CHANNEL

SOILS INFORMATION NOT AVAILABLE
SOILS CONDITIONS

The surficial soils observed during the site visit consisted of a light brown, silty fine sand with gravel and some boulders and rock outcrops. The site is located in a relatively narrow ravine, and the surficial soils appear to be residuals of the sandstone hill sides. A sample collected in the area of the proposed left abutment consisted of a light brown, silty sand, with auger refusal at 1 foot. A sample collected from the channel area consisted of a dark brown, silty to clayey, highly organic, sand. Auger refusal for the channel sample was met at 1.5 feet. No specific surficial soil mapping was available for this area. However, general soil mapping indicates that the soils in the vicinity of the Medicine Bow National Forest consist of gravely clay loams. However, there is a large potential for variability of surficial soil conditions. Based on our site visit, we do not anticipate that the surficial soils would be good for embankment construction. Embankment limitations are likely to be severe due to a potentially thin layer of acceptable embankment materials and the silty sand soils are potentially susceptible to piping. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

PRIMARY SOILS

No specific soil mapping available

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<td>AASHTO</td>
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<td>LL</td>
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RANKING CRITERIA

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<th>Criteria</th>
<th>Rank</th>
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<td>Suitability of Primary Embankment Soils:</td>
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<tr>
<td>Suitability of Secondary Embankment Soils:</td>
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<tr>
<td>Availability of Primary Embankment Soils:</td>
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<tr>
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Material Suitability/Availability Rank | 1
SOIL CONDITIONS

The sandy soils observed during the site visit consist of sandy clays to clayey sands. Erosional cuts along the stream channel indicated that the bedrock soils primarily consist of weathered sandstone with some shale. A sample collected from the proposed right abutment area consisted of a brown, sandy clay. These sandy clay soils are anticipated to be suitable embankment soils. A sample collected from the channel consisted of a brown, clayey sand, but these materials may also be acceptable embankment materials. Only partial surficial soil mapping was available for this area, but it appears that the primary soils in the embankment area consist of soils of the Blazon-Shinbara-Rentsac complex (Soil No. 563). The composition of this complex is 30 percent Blazon clay loam, 30 percent Shinbara loam and 20 percent Rentsac channery sandy loam. Blazon clay loams are classified as a medium plasticity sandy clay (CL), Shinbara loams are classified as a low plasticity sandy clay to sandy silt (CL, CL-ML) and Rentsac loams are classified as silty sand and gravel (GM). Embankment limitations are listed as severe due to a thin layer of available embankment materials. Secondary soils mapped in the area consist of soils of the Forelle-Diamondville complex (Soil No. 911) and soils of the Havre overflow (Soil No. 1321). Soils of the Forelle-Diamondville complex are classified as a medium plasticity clay loam (CL) with some sands and gravels. Soils of the Havre overflow are classified as a stratified loam and sandy loam exhibiting little to no plasticity and containing some gravel. Embankment limitations for these secondary soils vary from slight to severe due to the susceptibility of the materials to piping. Geologic mapping indicates that the proposed embankment lies near the boundary between the Fort Union Formation and the Lance Formation. The Fort Union formation consists of brown to gray sandstone, gray to black shale and some thin coal beds. The Lance formation consists of brown to gray sandstone and shale with thin coal beds and carbonaceous shale beds.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Blazon</th>
<th>Shinbara</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>clay loam</td>
<td>clay loam</td>
</tr>
<tr>
<td>USCS:</td>
<td>CL</td>
<td>CL</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-6</td>
<td>A-6</td>
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<tr>
<td>LL:</td>
<td>35-40</td>
<td>35-40</td>
</tr>
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<td>PI:</td>
<td>10-20</td>
<td>10-20</td>
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<td>Permeability (in/hr):</td>
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<td>0.2-0.6</td>
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<table>
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<tr>
<th>Blazon</th>
<th>USDA Texture:</th>
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<th>USCS:</th>
<th>CL</th>
<th>AASHTO:</th>
<th>A-6</th>
<th>LL:</th>
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<th>PI:</th>
<th>10-20</th>
<th>Permeability (in/hr):</th>
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<tbody>
<tr>
<td>R - 3&quot;</td>
<td>P #4:</td>
<td>80-100</td>
<td>P #10:</td>
<td>80-100</td>
<td>P #40:</td>
<td>75-95</td>
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</table>

INBERG-MILLER ENGINEERS
### SOIL PROPERTIES, Continued

#### PRIMARY SOILS, Continued

**Renisac**
- USDA Texture: channery sandy loam
- USCS: GM
- AASHTO: A-1
- LL: ---
- PI: NP

- Permeability (in/hr): 2.0-6.0

**SECONDARY SOILS**

**Forelle**
- USDA Texture: clay loam
- USCS: CL
- AASHTO: A-4, A-6
- LL: 25-40
- PI: 8-15

- Permeability (in/hr): 0.6-2.0

**Diamondville**
- USDA Texture: clay loam
- USCS: CL
- AASHTO: A-6,A-7
- LL: 35-45
- PI: 15-25

- Permeability (in/hr): 0.6-2.0

**Havre overflow**
- USDA Texture: stratified loam/sandy loam
- USCS: SM
- AASHTO: A-4,A-2
- LL: 15-30
- PI: NP

- Permeability (in/hr): 0.6-2.0

### RANKING CRITERIA

- Foundation Suitability: Good
- Suitability of Primary Embankment Soils: Good
- Suitability of Secondary Embankment Soils: Good
- Availability of Primary Embankment Soils: Good
- Availability of Secondary Embankment Soils: Poor

| Material Suitability/Availability Rank | 4 |

---

INBERG-MILLER ENGINEERS
SOIL CONDITIONS

The surficial soils observed during the site visit consist of a light brown, silty fine sand with some gravel. Numerous sandstone rock outcroppings were also observed within the channel and abutment areas. Samples collected from the channel and abutment areas were consistent with the surficial soils, with auger refusal be met at 1.5 feet in the channel and 1 foot near the abutment. Only partial surficial soil mapping was available for this area. The mapping indicates that the likely primary soils consist of soils from the Blazon-Shinbara-Rentsac complex (Soil No. 563). The composition of this complex is 30 percent Blazon clay loam, 30 percent Shinbara loam and 20 percent Rentsac channery sandy loam. Blazon clay loams are classified as a medium plasticity sandy clay (CL), Shinbara loams are classified as a low plasticity sandy clay to sandy silt (CL, CL-ML) and Renstac loams are classified as silty sand and gravel (GM). Embankment limitations are listed as severe due to a thin layer of available embankment materials. Secondary soils in the area are mapped as soils of the Havre-Glendale complex (Soil No. 900). The composition of this soil is 60 percent Havre very fine sandy loam and 20 percent Glendale sandy loam. The secondary soils are located approximately 200 feet northeast of the proposed embankment location. Embankment limitations for the secondary soils are listed as severe due to the susceptibility of the soils to piping, excess salt/sodium and difficulty to compact the soils. Geologic mapping indicates that this area is mapped as Alluvium and Colluvium and near the Fort Union formation. Alluvial and colluvial materials consist of variable amounts of clay, silt, sand and gravel located in flood plain, fans, terraces and slopes. The Fort Union formation consists of brown to gray sandstone, gray to black shale and some thin coal beds, and likely underlies the alluvial and colluvial materials.

SOIL PROPERTIES

PRIMARY SOILS

<table>
<thead>
<tr>
<th>Blazon</th>
<th>USDA Texture: clay loam</th>
<th>USCS: CL</th>
<th>AASHTO: A-6</th>
<th>LL: 35-40</th>
<th>PI: 10-20</th>
<th>Permeability (in/hr): 0.6-2.0</th>
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<tbody>
<tr>
<td></td>
<td>R - 3&quot;: 0-5</td>
<td>P #4: 80-100</td>
<td>P #10: 80-100</td>
<td>P #40: 75-95</td>
<td>P #200: 60-75</td>
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<table>
<thead>
<tr>
<th>Shinbara</th>
<th>USDA Texture: clay loam</th>
<th>USCS: CL</th>
<th>AASHTO: A-6</th>
<th>LL: 35-40</th>
<th>PI: 10-20</th>
<th>Permeability (in/hr): 0.2-0.6</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>R - 3&quot;: 0-5</td>
<td>P #4: 80-100</td>
<td>P #10: 80-100</td>
<td>P #40: 75-95</td>
<td>P #200: 60-75</td>
<td></td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

PRIMARY SOILS, Continued

Rentsac
USDA Texture: channery sandy loam
USCS: GM
AASHTO: A-1
LL: ---
PI: NP
Permeability (in/hr): 2.0-6.0

SECONDARY SOILS

Havre
USDA Texture: very fine sandy loam
USCS: ML
AASHTO: A-4
LL: 15-25
PI: NP-5
Permeability (in/hr): 0.6-2.0

Glendive
USDA Texture: sandy loam
USCS: SM, SM-SC
AASHTO: A-2, A-4
LL: 10-25
PI: NP-10
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Very Poor
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Very Poor
Availability of Primary Embankment Soils: Poor
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 2 |

INBERG-MILLER ENGINEERS
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consist of a brown, silty fine sand with gravel and cobbles. Samples collected from the channel and the abutment area are consistent with the surficial soils. Auger refusal was met at 1 foot in the abutment and 3 feet in the channel. Surficial soil mapping indicates that the primary soils in the area consist of soils of the Havre-Glendive complex (Soil No. 900) and soils of the Rock River-Ryark-Cushool complex (Soil No. 234). The primary soils are separated by the stream channel with the Havre-Glendive soils on the west side of the channel and the Rock River-Ryark-Cushool soils on the east side of the channel. The composition of the Havre-Glendive soils consist of 60 percent Havre very fine sandy loam and 20 percent Glendive sandy loam. The composition of the Rock River-Ryark-Cushool soils is 30 percent Rock River sandy loam, 25 percent Ryark sandy loam and 15 percent Cushool sandy loam. Embankment limitations are listed as severe due to piping potential, excess salt/sodium and only a thin layer of available embankment materials. Secondary soils are mapped as soils of the Forelle-Diamondville complex (Soil No. 911). The composition of these soils is 60 percent Forelle loam and 20 percent Diamondville loam. These secondary soils are generally a low plasticity clay loam soils and are located approximately 300 feet west of the proposed embankment. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Havre</th>
<th>Glendive</th>
<th>Rock River</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>very fine sandy loam</td>
<td>sandy loam</td>
<td>sandy clay loam</td>
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<tr>
<td>USCS:</td>
<td>ML</td>
<td>SM, SM-SC</td>
<td>SM, SM-SC</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-4</td>
<td>A-2, A-4</td>
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<tr>
<td>LL:</td>
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<tr>
<td>PI:</td>
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<td>0.6-2.0</td>
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</tbody>
</table>

INBERG-MILLER ENGINEERS
**SOIL PROPERTIES**. Continued  

**PRIMARY SOILS**, Continued  

**Ryark**  
USDA Texture: sandy loam  
USCS: SM  
AASHTO: A-1, A-2  
LL: -  
PI: NP  
Permeability (in/hr): 2.0-6.0

**Cushool**  
USDA Texture: sandy loam  
USCS: SM  
AASHTO: A-2  
LL: -  
PI: NP  
Permeability (in/hr): 2.0-6.0

**SECONDARY SOILS**  

**Forelle**  
USDA Texture: clay loam  
USCS: CL  
AASHTO: A-4, A-6  
LL: 25-40  
PI: 8-15  
Permeability (in/hr): 0.6-2.0

**Diamondville**  
USDA Texture: clay loam  
USCS: CL  
AASHTO: A-6,A-7  
LL: 35-45  
PI: 15-25  
Permeability (in/hr): 0.6-2.0

**RANKING CRITERIA**

Foundation Suitability: Poor  
Suitability of Primary Embankment Soils: Very Poor  
Suitability of Secondary Embankment Soils: Fair  
Availability of Primary Embankment Soils: Poor  
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 2 |

INBERG-MILLER ENGINEERS
DOTY MOUNTAIN 5

SOIL CONDITIONS

Based on surficial soil conditions observed in the area during the site visit, the surficial soils appear to consist of a tan, fine sandy silt to silty fine sand. A rock outcrop (proposed right abutment) consisted of a weathered sandstone. A sample collected from the channel area consisted of 2 to 3 feet of highly organic, clayey to silty fine sand. Below 3 feet, a sandy clay was encountered. A sample collected from the proposed left abutment area consisted of 1 foot of tan, fine sandy silt overlying a clayey fine sand. Surficial soil mapping indicates that this area is mapped as soils of the Seaverson-Blazon complex (Soil No. 237). The composition of this soil is 40 percent Seaverson clay loam and 30 percent Blazon loam. Seaverson soils exhibit low plasticity and are classified as a silty to sandy clay (CL). Blazon soils exhibit low plasticity and are classified as a silt to a silty clay (ML, CL-ML). These soils possess plasticity indexes ranging from 5 to 10 with 55 to 70 percent passing the No. 200 sieve. Embankment limitations are listed as severe due to the line layer of available materials. Possible secondary soils within the area are mapped as soils of the Cushool-Diamondville-Worfman complex (Soil No. 247). The composition of this soil is 40 percent Cushool sandy loam, 25 percent Diamondville loam and 20 percent Worfman sandy loam. These secondary soils are located approximately 500 feet from the proposed embankment area, outside of the area bounded by the high water line. These secondary soils are generally considered to be sandy loam to sandy clay loams. Material properties are shown below. Geologic mapping shows this area to be mapped as Lewis Shale. Lewis Shale is classified as gray marine shale containing many gray and brown lenticular concretion-rich sandstone beds.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
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<th></th>
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</tr>
</thead>
<tbody>
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<tr>
<td></td>
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<td>CL</td>
<td>P #4: 80-100</td>
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<td></td>
<td>AASHTO:</td>
<td>A-6</td>
<td>P #10: 80-100</td>
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<tr>
<td></td>
<td>LL:</td>
<td>35-40</td>
<td>P #40: 75-95</td>
</tr>
<tr>
<td></td>
<td>PI:</td>
<td>10-20</td>
<td>P #200: 60-75</td>
</tr>
<tr>
<td></td>
<td>Permeability (in/hr): 0.2-0.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Blazon                 | USDA Texture: | loam | R - 3": 0-5 |          |
|                        | USCS:        | ML,CL-ML | P #4: 80-100 |          |
|                        | AASHTO:     | A-4   | P #10: 80-100 |          |
|                        | LL:         | 25-35 | P #40: 70-90 |          |
|                        | PI:         | 5-10  | P #200: 55-70 |          |
|                        | Permeability (in/hr): 0.6-2.0 |          |          |
SOIL PROPERTIES, Continued

SECONDARY SOILS

Cushool
- USDA Texture: sandy clay loam
- R - 3": 0
- USCS: SM
- P #4: 75-100
- AASHTO: A-4
- P #10: 75-100
- LL: 30-40
- P #40: 65-85
- PI: 5-10
- P #200: 35-50
- Permeability (in/hr): 0.6-2.0

Diamondville
- USDA Texture: clay loam
- R - 3": 0-5
- USCS: CL
- P #4: 95-100
- AASHTO: A-6,A-7
- P #10: 95-100
- LL: 15-25
- P #40: 85-95
- PI: 5-10
- P #200: 85-95
- Permeability (in/hr): 0.6-2.0

Worfman
- USDA Texture: sandy clay loam
- R - 3": 0
- USCS: CL
- P #4: 85-100
- AASHTO: A-6
- P #10: 85-100
- LL: 30-40
- P #40: 70-90
- PI: 10-20
- P #200: 50-75
- Permeability (in/hr): 0.6-2.0

RANKING CRITERIA

- Foundation Suitability: Good
- Suitability of Primary Embankment Soils: Fair
- Suitability of Secondary Embankment Soils: Fair
- Availability of Primary Embankment Soils: Poor
- Availability of Secondary Embankment Soils: Poor

| Material Suitability/Availability Rank | 3 |
SOIL CONDITIONS

The surficial soils observed during the site visit consist of weathered sandstones and shales. Samples collected from the channel and abutment area were similar and consisted of interbedded light brown, sandy clay to clayey sand. Auger refusal was met at 3 feet due to hard conditions. Surficial soil mapping indicates that the primary soils in the area consist of soils of the Forelle-Patent complex (Soil No. 233). The composition of this complex is 40 percent Forelle loam and 30 percent Patent loam. The Forelle-Patent soils are a fine grained soil that exhibit low to medium plasticity. Embankment limitations are listed as slight to severe due to the piping potential of the embankment soils. Secondary soils mapped in the area consist of soils of the Blazon-Shinbara-Rentsac complex (Soil No. 563) and soils of the Echemoor-Vabem complex (Soil No. 119). The Blazon-Shinbara-Rentsac soils are located approximately 400 feet north west of the proposed embankment, with the composition of 30 percent of Blazon clay loam, 30 percent Shinbara loam and 20 percent Rentsac channery sandy loam. For soil properties of the Blazon-Shinbara-Rentsac complex see the site summary for the Dixon 15 site. Soils of the Echemoor-Vabem complex are located approximately 400 feet east of the proposed embankment, with the composition of 50 percent Echemoor loam and 40 percent Vabem loam. The Blazon-Shinbara-Rentsac soils are generally a low to medium plasticity, gravelly clay loam, while the Echemoor-Vabem soils are a low to no plasticity, silty clay loam to silty loam soil. Embankment limitations for the secondary soils are listed as severe due to a thin layer of available materials, susceptibility to piping and excess salt/sodium. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

PRIMARY SOILS

<table>
<thead>
<tr>
<th>Soil</th>
<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
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<th>Permeability (in/hr)</th>
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<tbody>
<tr>
<td>Forelle</td>
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<tr>
<td>Patent</td>
<td>loam</td>
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<td>50-90</td>
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</tbody>
</table>

INBERG-MILLER ENGINEERS
GARDEN GULCH 3

SOIL PROPERTIES
SECONDARY SOILS
Echemoor
USDA Texture: clay loam R - 3": 0
USCS: CL P #4: 75-100
AASHTO: A-6 P #10: 75-100
LL: 30-40 P #40: 70-100
PI: 15-20 P #200: 50-80
Permeability (in/hr): 0.6-2.0

Vabem
USDA Texture: loam R - 3": 0-25
USCS: CL-ML, ML P #4: 85-100
AASHTO: A-4 P #10: 85-100
LL: 25-35 P #40: 75-90
PI: 5-10 P #200: 55-75
Permeability (in/hr): 0.2-0.6

RANKING CRITERIA

Foundation Suitability: Good
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Fair
Availability of Primary Embankment Soils: Good
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 3 |

INBERG-MILLER ENGINEERS
LEGEND

- Soil Boundary
- Reservoir HWL
- Contour line (20' interval)
- Stream Channel

PRIMARY

- Forelle-Patent Complex
  - 20% Forelle Loam
  - 30% Patent Loam

SECONDARY

- Blazon-Shinbara-Rentsac Complex
  - 50% Blazon Clay Loam
  - 30% Shinbara Loam
  - 20% Rentsac Channery Sandy Loam
  - Echemoor-Vabem Loams
    - 15% Echemoor Loam
    - 40% Vabem Loam
  - Shinbara-Blazon-Rentsac Complex
    - 25% Shinbara Loam
    - 30% Blazon Loam
    - 15% Rentsac

INBERG-MILLER ENGINEERS
1120 E. C STREET CASPER, WYOMING
82601 307-577-0806
SOIL CONDITIONS

The surficial soil conditions consist of light brown, sandy clays and silts and with numerous cobbles, boulders and sandstone rock outcroppings. It is anticipated that a relatively large embankment (approximately 35 feet high) would be constructed at this site. A sample collected from the channel consisted of a brown, silty fine sand, with auger refusal be met at 2 feet. A sample collected from the right abutment consisted of a light brown, fine sandy clay to clay sand, with auger refusal at 1 foot. Surficial soil mapping indicates that the primary soils are mapped as soils of the Forelle-Patent complex (Soil No. 233). The composition of this complex is 40 percent Forelle loam and 30 percent Patent loam. The Forelle-Patent soils are a fine grained soil that exhibits low to medium plasticity. Embankment limitations are listed as slight to severe due to the piping potential of the embankment soils. Secondary soils mapped in the area consist of soils of the Blazon-Shinbara-Rentsac complex (Soil No. 563). The Blazon-Shinbara-Rentsac soils are located on each side of the stream channel, approximately 200 feet from the stream channel. The composition of this complex is 30 percent Blazon clay loam, 30 percent Shinbara loam and 20 percent Rentsac channery sandy loam. Soils of the Blazon-Shinbara-Rentsac complex are generally a gravelly clay loam exhibiting low to medium plasticity. Embankment limitations for the secondary soils are listed as severe due to a thin layer of available materials, susceptibility to piping and excess salt/sodium. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
</tr>
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<tbody>
<tr>
<td>Forelle</td>
</tr>
<tr>
<td>USDA Texture: clay loam</td>
</tr>
<tr>
<td>USCS: CL</td>
</tr>
<tr>
<td>AASHTO: A-4, A-6</td>
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<td>LL: 25-40</td>
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<td>PI: 8-15</td>
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<td>Permeability (in/hr): 0.6-2.0</td>
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</table>
SOIL PROPERTIES. Continued

SECONDARY SOILS

Blazon
USDA Texture: clay loam
USCS: CL
AASHTO: A-6
LL: 35-40
PI: 10-20
Permeability (in/hr): 0.6-2.0

Shinbara
USDA Texture: clay loam
USCS: CL
AASHTO: A-6
LL: 35-40
PI: 10-20
Permeability (in/hr): 0.2-0.6

Rentsac
USDA Texture: channery sandy loam
USCS: GM
AASHTO: A-1
LL: ---
PI: NP
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 3 |
**SOIL CONDITIONS**

The surficial soils observed during the site visit consist of weathered shales and sandstones. Numerous erosional cuts were observed along the stream channel, possibly indicating that the soils are susceptible to erosion. Additionally, an embankment was observed approximately 1 mile downstream from the proposed embankment. This embankment appears to have been recently constructed and did not appear to have been exposed to much water. The embankment was dry at the time of our visit. Samples collected from the channel and the abutment area of the proposed embankment consisted of very similar materials. The top foot of the sample consisted of a light grayish brown, fine sandy silt. Beneath the top foot of soil is a light grayish brown, clayey fine sand to fine sandy clay. It appears that the clay content of the soils increase with depth. Surficial soil mapping indicates that the primary soils in the area are mapped as soils of the Forelle-Patent complex (Soil No. 233). The composition of this complex is 40 percent Forelle loam and 30 percent Patent loam. The Forelle-Patent soils are a fine grained soil that exhibit low to medium plasticity. Embankment limitations are listed as slight to severe due to the piping potential of the embankment soils. The secondary soils in the area are listed as soils of the Starman-Barrett complex and soils of the Echemoor-Vabem complex. The soils of the Starman-Barrett complex are located approximately 500 feet north of the proposed embankment and are generally classified as gravelly loams exhibiting low plasticity. The soils of the Echemoor-Vabem complex are located approximately 200 feet south of the proposed embankment and generally consist of a loam to clay loam soil exhibiting low plasticity. Embankment limitations are listed as moderate to severe due to a thin layer of available materials and the susceptibility of the materials to piping. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

**SOIL PROPERTIES**

**PRIMARY SOILS**

<table>
<thead>
<tr>
<th>Soil</th>
<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
<th>Permeability (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forelle</td>
<td>clay loam</td>
<td>CL</td>
<td>A-4, A-6</td>
<td>25-40</td>
<td>8-15</td>
<td>0.6-2.0</td>
</tr>
<tr>
<td>Patent</td>
<td>loam</td>
<td>CL, CL-ML</td>
<td>A-4, A-6</td>
<td>20-35</td>
<td>3-18</td>
<td>0.6-2.0</td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

SECONDARY SOILS

**Starman**
- USDA Texture: gravelly loam
- USCS: GM
- AASHTO: A-1, A-2
- LL: 30-40
- PI: 5-10
- Permeability (in/hr): 0.6-2.0

**Barrett**
- USDA Texture: shallow loamy
- USCS: N/A
- AASHTO: N/A
- LL: N/A
- PI: N/A
- Permeability (in/hr): N/A

**Echemoor**
- USDA Texture: clay loam
- USCS: CL
- AASHTO: A-6
- LL: 30-40
- PI: 15-20
- Permeability (in/hr): 0.6-2.0

**Vabem**
- USDA Texture: loam
- USCS: CL-ML, ML
- AASHTO: A-4
- LL: 25-35
- PI: 5-10
- Permeability (in/hr): 0.2-0.6

RANKING CRITERIA

| Material Suitability/Availability Rank | 3 |

INBERG-MILLER ENGINEERS
SOIL CONDITIONS
The surficial soil conditions observed during the site visit appear to consist of alluvial and colluvial deposits of clay, silt, sand and gravel overlying a sandstone bedrock. Some sandstone outcroppings were observed in the area. A sample collected from the channel area consisted of 3.5 feet of a silty to clayey, fine sand. Water was encountered in the channel sample at 3.5 feet. We were unable to go beyond 3.5 feet due to the water. A sample collected from the proposed abutment area consisted of a light brown, silty fine sand with gravel. Auger refusal was met at 1 foot due to rocky conditions. Surficial soil mapping of the area indicates that the primary soils in the area of the proposed embankment consist of soils of the Peyton-Evanston complex (Soil No. 1441). The composition of this complex was not able to be determined. Peyton soils are generally considered to be a loamy coarse sand exhibiting little to no plasticity and are classified as a silty sand (SM). The Evanston soils are a clay loam soil exhibiting moderate plasticity and are classified as a silty to sandy clay (CL). Embankment limitations are listed as moderate due to the susceptibility of the materials to piping of the embankment soils. Secondary soils mapped in the area consist of soils that have not been formally assigned a specific soil composition. Soil mapping indicates that the soils have only been assigned a general soil taxonomy description of Cumulic Haploborolls. Cumulic Haploborolls are generally a loamy soil, however, no other specific soil properties are listed. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

**PRIMARY SOILS**

**Peyton**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture</td>
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<td>SM</td>
<td>A-1, A-2</td>
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<td>NP</td>
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<td>USCS:</td>
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<td></td>
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</tr>
<tr>
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<td>LL:</td>
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<td></td>
</tr>
<tr>
<td>PI:</td>
<td></td>
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<tr>
<td>Permeability</td>
<td>2.0-6.0</td>
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</table>

**Evanston**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
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</thead>
<tbody>
<tr>
<td>USDA Texture</td>
<td>clay loam</td>
<td>CL</td>
<td>A-6</td>
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<td>10-15</td>
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<td>USCS:</td>
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</tr>
<tr>
<td>AASHTO:</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
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<tr>
<td>PI:</td>
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<td>Permeability</td>
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</table>
SOIL PROPERTIES. Continued

SECONDARY SOILS
Cumulic Haploborolls
USDA Texture: loamy
USCS: N/A
AASHTO: N/A
LL: N/A
PI: N/A
Permeability (in/hr): N/A

RANKING CRITERIA

Foundation Suitability: Poor
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Poor

| Material Suitability/Availability Rank | 2 |
SOIL CONDITIONS

The surficial soils observed during the site visit consisted of a light brown, silty fine sand with some sandstone rock outcroppings in the area. A sample collected from the channel area consisted of 1 foot of a silty sand topsoil overlying a grayish brown, sandy clay. The sample collected from the proposed abutment area consisted of a brown, silty to clayey fine sand. Auger refusal was met at 3 feet in the channel sample and at 1.5 feet in the abutment sample. Surficial soil mapping of the area indicates that the primary soils consist of soils of the Echemoor-Vabem complex (Soil No. 119). The composition of the complex is 50 percent Echemoor loam and 40 percent Vabem loam. Echemoor soils are listed as a clay loam soil exhibiting medium plasticity. However there is typically a surficial silty soil associated with Echemoor soils. Vabem soils are listed as a loam soil exhibiting low plasticity. Embankment limitations are listed as moderate to severe due to the susceptibility to piping of the embankment soils and due to a thin layer of available embankment materials. Secondary soils in the area consist of the Hesperus-Peyton complex (Soil No. 1483) and soils of the Lymanson-Barrett complex (Soil No. 1445). The soils of the Hesperus-Peyton complex are located approximately 100 feet north of the proposed embankment and soils of the Lymanson-Barrett complex are located approximately 300 feet east of the proposed embankment. Soils properties of both of the secondary soils are generally a loamy soil exhibiting low to medium plasticity. Soil properties are shown below. Embankment limitations of the secondary soils are listed as severe due to a thin layer of available materials and the susceptibility of the materials to piping. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
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<tbody>
<tr>
<td>Echemoor</td>
</tr>
<tr>
<td>USDA Texture: clay loam</td>
</tr>
<tr>
<td>USCS:         CL</td>
</tr>
<tr>
<td>AASHTO:       A-6</td>
</tr>
<tr>
<td>LL:           30-40</td>
</tr>
<tr>
<td>PI:           15-20</td>
</tr>
<tr>
<td>Permeability (in/hr): 0.6-2.0</td>
</tr>
<tr>
<td>Vabem</td>
</tr>
<tr>
<td>USDA Texture: loam</td>
</tr>
<tr>
<td>USCS:         CL-ML, ML</td>
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<tr>
<td>AASHTO:       A-4</td>
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<td>PI:           5-10</td>
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<tr>
<td>Permeability (in/hr): 0.2-0.6</td>
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</table>
SOIL CONDITIONS, Continued

SECONDARY SOILS

Hesperus
USDA Texture: clay loam  
USCS: CL  
AASHTO: A-6  
LL: 30-40  
PI: 10-20  
Permeability (in/hr): 0.6-2.0

USCS: CL  
P #4: 90-100  
P #10: 90-100  
P #40: 80-95  
P #200: 70-85

Peyton
USDA Texture: loamy coarse sand  
USCS: SM  
AASHTO: A-1, A-2  
LL: ---  
PI: NP  
Permeability (in/hr): 2.0-6.0

USCS: SM  
P #4: 80-100  
P #10: 35-85  
P #40: 20-50  
P #200: 10-35

Lymanson
USDA Texture: gravelly loam  
USCS: CL-ML  
AASHTO: A-4  
LL: 25-35  
PI: 5-10  
Permeability (in/hr): 0.6-2.0

USCS: CL-ML  
P #4: 75-100  
P #10: 75-100  
P #40: 65-85  
P #200: 50-65

Barrett
USDA Texture: loamy  
USCS: N/A  
AASHTO: N/A  
LL: N/A  
PI: N/A  
Permeability (in/hr): N/A

USCS: N/A  
P #4: N/A  
P #10: N/A  
P #40: N/A  
P #200: N/A

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 3 |
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consist of alluvial and colluvial deposits of clay, silt, sand and gravel overlying a weathered sandstone. A sample collected from the channel area consists of an organic sandy clay to clayey sand to a depth of 2 feet. From 2 to 3 feet is a bluish gray, clayey fine sand, with auger refusal at 3 feet. A sample collected from the abutment area consisted of a brown, silty fine sand to a depth of 3 feet, and a light brown sandy clay to clayey sand from 3 to 5 feet. Surficial soil mapping indicates that the proposed embankment borders on two primary soils types with the stream channel separating the two soil complexes. The primary soils consist of soils of the Peyton-Evanston complex (Soil No. 1441) and soils of the Lymanson-Barrett complex (Soil No. 1445). The composition of these complexes was not able to be determined. Peyton soils are generally considered to be a loamy coarse sand exhibiting little to no plasticity and are classified as a silty sand (SM). The Evanston soils are a clay loam soil exhibiting moderate plasticity and are classified as a silty to sandy clay (CL). Embankment limitations for the Peyton-Evanston complex are listed as moderate due to the potential for piping of the embankment soils. Lymanson soils are generally considered to be a gravelly loam exhibiting low to medium plasticity. The Lymanson soils are classified as a gravelly silty clay (CL-ML). No specific soil properties were available for the Barrett soils but are generally classified as a very shallow loamy soil. Embankment limitations for the Lymanson-Barrett complex are listed as moderate to severe due to a thin layer of available materials. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
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<tr>
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<tr>
<td>AASHTO:</td>
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SOIL PROPERTIES. Continued

PRIMARY SOILS, Continued

Lymanson

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<th>USDA Texture:</th>
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<tr>
<td>USCS:</td>
<td>CL-ML</td>
<td>P #4:</td>
<td>75-100</td>
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<td>AASHTO:</td>
<td>A-4</td>
<td>P #10:</td>
<td>75-100</td>
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<tr>
<td>LL:</td>
<td>25-35</td>
<td>P #40:</td>
<td>65-85</td>
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<tr>
<td>PI:</td>
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<td>P #200:</td>
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<td>Permeability (in/hr):</td>
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Barrett

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<tr>
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<td>N/A</td>
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<td>LL:</td>
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<tr>
<td>Permeability (in/hr):</td>
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RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Poor

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
</tr>
</thead>
</table>

KETCHUM BUTTES 34
LEGEND

- Soil Boundary
- Reservoir Hwl
- Contour Line (20' Interval)
- Stream Channel

PRIMARY

Peyton–Evanston Complex
1444 Peyton Loam
1445 Evanston Loam

Lymanson–Barrett Complex
1446 Lymanson Loam
1447 Barrett Loam
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of alluvial and colluvial deposits of clay, silt, sand and gravel overlying a weathered sandstone. Numerous rock outcroppings were observed in the area. Samples collected from the proposed abutment area and the channel consisted of a brown, silty to clayey sand to a depth of 3 feet. Auger refusal was met at 3 feet in both samples. Additionally, the nearby roadway that accesses the site is very clayey and may be a further indication of clayey soils in the area. Surficial soil mapping indicates that the primary soils in the area consist of soils of the Hesperus-Peyton complex (Soil No. 1483). The composition of these soils was not available. Hesperus soils are generally considered to be a clay loam soil exhibiting medium plasticity. Peyton soils are generally classified as a silty sand exhibiting no plasticity. Embankment limitations are listed as moderate due to the susceptibility of the materials to piping. Secondary soils in the area are mapped as soils of the Lymanson-Barrett-Rentsac complex (Soil No. 1444). The composition of these secondary soils was not available. However, Lyman-Barrett-Rentsac soils are generally classified as loam to clay loam soils containing a significant amount of gravel. These secondary soils are located approximately 1000 feet north from the proposed embankment. Embankment limitations for the secondary soils are listed as moderate to severe due to a thin layer of available materials, the potential for piping of the embankment materials and the difficulty to compact the embankment materials. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Hesperus</th>
<th>Peyton</th>
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</thead>
<tbody>
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<td>USDA Texture:</td>
<td>clay loam</td>
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<td>AASHTO:</td>
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<td>A-1, A-2</td>
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<tr>
<td>LL:</td>
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<tr>
<td>Permeability (in/hr):</td>
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<td>2.0-6.0</td>
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</tbody>
</table>

|             | R - 3":        | P #4:       | P #10:     | P #40:      | P #200:     |
| R - 3":     | 0-5            | 90-100      | 90-100     | 80-95       | 70-85       |
| P #4:       | 80-100         | 35-85       | 20-50      | 10-35       |             |
| P #10:      |                |             |            |             |             |
| P #40:      |                |             |            |             |             |
| P #200:     |                |             |            |             |             |

INBERG-MILLER ENGINEERS
SOIL PROPERTIES, Continued

SECONDARY SOILS

Lymanson
USDA Texture: gravelly loam  
USCS: CL-ML  
AASHTO: A-4  
LL: 25-35  
PI: 5-10  
Permeability (in/hr): 0.6-2.0

Barrett
USDA Texture: loamy  
USCS: N/A  
AASHTO: N/A  
LL: N/A  
PI: N/A  
Permeability (in/hr): N/A

Rentsac
USDA Texture: channery sandy loam  
USCS: GM  
AASHTO: A-1  
LL: ---  
PI: NP  
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Fair  
Suitability of Primary Embankment Soils: Fair  
Suitability of Secondary Embankment Soils: Poor  
Availability of Primary Embankment Soils: Fair  
Availability of Secondary Embankment Soils: Poor

| Material Suitability/Availability Rank | 3 |
SOIL CONDITIONS

The surficial soils observed during the site visit consist of a light brown, silty to clayey sand. This site consists of an existing embankment that was reportedly constructed in the 1950's. The existing embankment failed due to erosion of the principal spillway. The existing embankment was constructed such that the principal spillway was a part of the embankment. Spillway erosion eventually led to erosion of the embankment itself. A sample collected from the existing embankment consisted of a light brown, silty to clayey fine sand, consistent with the surficial soils in the area. Another sample taken from the stream channel approximately 100 feet upstream from the existing embankment, consisted of an interbedded light brown, silty to clayey fine sand and a red, silty clay (probable shale). It is anticipated that the existing embankment may be suitable for repair. Surficial soil mapping in the area indicates that the primary soils in the area consist of Glenderson fine sandy loam (Soil No. 908). Soils of the Glenderson complex are stratified sandy loam exhibiting low to no plasticity. Embankment limitations are listed as severe for the Glenderson soils due to seepage potential. Secondary soils in the area consist of soils classified as the Havre overflow complex (Soil No. 1321), located approximately 300 feet south of the existing embankment, and soils of the Blazon-Chaperton-Rock Outcrop complex (Soils No. 281), located approximately 700 feet north of the existing embankment. Soils of the Havre overflow are classified as a stratified loam and sandy loam exhibiting little to no plasticity and containing some gravel. Soils of the Blazon-Chaperton complex are clay loam soils exhibiting low to moderate plasticity. Embankment limitations for the Havre soils are listed as severe due to the embankment materials being susceptible to piping and moderate to severe for the Blazon-Chaperton soils due to a thin layer of available embankment materials. Soil properties are listed below. Geologic mapping shows the proposed embankment area to be mapped near the boundary of two geologic formations, alluvial and colluvial deposits consisting of clay, silt, sand and gravel, and the main body of the Wasatch formation. The Wasatch formation consists of drab sandstone and drab to variegated claystone and siltstone.

SOIL PROPERTIES

| PRIMARY SOILS | Glenderson | USDA Texture: | stratified sandy loam | R - 3": | 0 |
| | | USCS: | ML, CL-ML | P #4: | 100 |
| | | AASHTO: | A-4 | P #10: | 100 |
| | | LL: | 15-25 | P #40: | 80-95 |
| | | PI: | NP-10 | P #200: | 50-80 |
| | | Permeability (in/hr): | 0.6-2.0 |

| SECONDARY SOILS | Havre overflow | USDA Texture: | stratified loam/sandy loam | R - 3": | 0 |
| | | USCS: | SM | P #4: | 95-100 |
| | | AASHTO: | A-4,A-2 | P #10: | 75-100 |
| | | LL: | 15-30 | P #40: | 60-80 |
| | | PI: | NP-4 | P #200: | 25-45 |
| | | Permeability (in/hr): | 0.6-2.0 |
SOIL PROPERTIES, Continued

SECONDARY SOILS, Continued

Blazon

USDA Texture: clay loam
USCS: CL
AASHTO: A-6
LL: 35-40
PI: 10-20
Permeability (in/hr): 0.6-2.0

Chaperton

USDA Texture: clay loam
USCS: CL
AASHTO: A-6, A-7
LL: 30-45
PI: 15-30
Permeability (in/hr): 0.6-2.0

RANKING CRITERIA

Foundation Suitability: Good
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Good
Availability of Primary Embankment Soils: Good
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 3 |

INBERG - MILLER ENGINEERS
SOILS CONDITIONS

The surficial soils observed during the site visit consisted of tan, silty fine sands, with some sandstone rock outcroppings. A sample collected from the proposed abutment area consisted of 3 feet of tan, silty fine sand overlying a olive brown, sandy clay from 3 to 5 feet. It is anticipated that the sandy clay soils would make good embankment materials. A sample collected from the channel area consisted of 3 feet of tan, silty fine sand with auger refusal being met at 3 feet. Surficial soil mapping indicates that the proposed embankment is located near the boundary of two soil types, Havre overflow soils (Soil No. 1321) and soils of the Cushool-Rock River complex (Soil No. 225). Soils of the Havre overflow are classified as a stratified loam and sandy loam exhibiting little to no plasticity and containing some gravel. Embankment limitations are listed as severe due to the embankment materials being susceptible to piping. Soils of the Cushool-Rock River complex are comprised of 50 percent Cushool sandy loam and 30 percent Rock River sandy loam. Cushool soils are generally a fine grained soil, which exhibit little to no plasticity and are classified as a silty sand (SM). Rock River soils are generally a fine to coarse grained soil, which exhibit medium to no plasticity and are classified as a silty sand to a silty, clayey sand (SM, SC-SM). Embankment limitations are listed as severe due to a thin layer of available materials and the materials are susceptible to piping. Secondary soils mapped in the area consist of soils of the Dines-Dines overflow complex (Soil No. 449). Dines-Dines overflow soils are generally silty loam to silty clay loam soils exhibiting medium to high plasticity. These secondary soils are located approximately 700 feet north of the proposed embankment location. Embankment limitations for the secondary soils are listed as severe due to susceptibility of the materials to piping, excess salt/sodium and difficulty in compacting the materials. Geologic mapping shows this area to be mapped as Lewis Shale. Lewis Shale is classified as gray marine shale containing many gray and brown lenticular concretion-rich sandstone beds.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Havre overflow</th>
<th>Cushool</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture</td>
<td>stratified loam/sandy loam</td>
<td>sandy loam</td>
</tr>
<tr>
<td>USCS:</td>
<td>SM</td>
<td>SM</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-4, A-2</td>
<td>A-4</td>
</tr>
<tr>
<td>LL:</td>
<td>15-30</td>
<td>---</td>
</tr>
<tr>
<td>PI:</td>
<td>NP-4</td>
<td>NP</td>
</tr>
<tr>
<td>Permeability (in/hr)</td>
<td>0.6-2.0</td>
<td>2.0-6.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

PRIMARY SOILS, Continued

Rock River
USDA Texture: sandy clay loam
USCS: SM, SC-SM
AASHTO: A-4
LL: 15-25
PI: NP-10
Permeability (in/hr): 0.6-2.0

SECONDARY SOILS

Dines and Dines overflow
USDA Texture: silty clay loam
USCS: CL
AASHTO: A-6
LL: 30-40
PI: 15-20
Permeability (in/hr): 0.2-0.6

RANKING CRITERIA

Foundation Suitability: Good
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Good
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Good

| Material Suitability/Availability Rank | 3 |
SOIL CONDITIONS

The surficial soils observed during the site visit consist of a brown silty, fine sand. Numerous sandstone rock outcroppings were observed on the ridges above the proposed embankment area. A sample collected from the channel area consisted of 1 foot of a brown, silty sand overlying a dark brown to brown, clayey to silty fine sand from 1 to 4 feet. A sample collected from the proposed abutment area consisted of 3 feet of a dark brown, silty fine sand overlying a light brown, silty fine sand from 3 to 4 feet. Surficial soil mapping of the area indicates that the primary soils in the area consist of soils of the Echemoor-Haggerty complex (Soil No. 101). The composition of this soil complex was not able to be determined. Echemoor soils are generally a loam soil overlying a clay loam soil. These Echemoor soils are a fine grained soil exhibiting medium plasticity. No soil properties were able to be determined for Haggerty soils, however, Haggerty soils are generally considered a loamy soil. Embankment limitations for this soil complex are listed as moderate due to a thin layer of available materials and the potential for seepage through the embankment materials. Secondary soils mapped in the area of the proposed embankment consist of soils of the Wrenman-Starman complex (Soil No. 104). Wrenman-Starman soils are generally a loam to gravelly loam soil exhibiting low to medium plasticity. Embankment limitations for these soils are listed as severe due to a thin layer of available materials and the potential for piping of the embankment materials. The secondary soils are located approximately 200 feet north west of the proposed embankment. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

PRIMARY SOILS

<table>
<thead>
<tr>
<th>Soil</th>
<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
<th>Permeability (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echemoor</td>
<td>clay loam</td>
<td>CL</td>
<td>A-6</td>
<td>30-40</td>
<td>15-20</td>
<td>0.6-2.0</td>
</tr>
<tr>
<td>Haggerty</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<table>
<thead>
<tr>
<th>Property</th>
<th>Echemoor</th>
<th>Haggerty</th>
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<tbody>
<tr>
<td>USCS:</td>
<td>CL</td>
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</tr>
<tr>
<td>AASHTO:</td>
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</tr>
<tr>
<td>LL:</td>
<td>30-40</td>
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<td>PI:</td>
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</tr>
<tr>
<td>Permeability (in/hr):</td>
<td>0.6-2.0</td>
<td>N/A</td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

SECONDARY SOILS

Wrenman
USDA Texture: loam
USCS: CL-ML
AASHTO: A-4
LL: 25-35
PI: 5-10
Permeability (in/hr): 0.6-2.0

Starman
USDA Texture: gravelly loam
USCS: GM
AASHTO: A-1, A-2
LL: 30-40
PI: 5-10
Permeability (in/hr): 0.6-2.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Good
Availability of Secondary Embankment Soils: Poor

Material Suitability/Availability Rank 3
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of a brown, silty to sandy clay. A sample collected from the abutment area consisted of 1 foot of brown, sandy silt topsoil, overlying a brown, clayey sand to sandy clay to 4 feet. This brown, sandy clay soil appeared to contain more clay with depth. It is anticipated that this clayey soil would make a good embankment material. A sample collected from the channel area consisted of an organic, dark brown to dark gray silty clay with water being encountered at approximately 1 foot. Surficial soil mapping indicates that the primary soils mapped in the area of the proposed embankment consist of soils of the Echemoor-Haggerty complex (Soil No. 101). Echemoor-Haggerty soils are generally classified as loam to clay loam soils exhibiting low to medium plasticity. Embankment limitations for the Echemoor-Haggerty soils are listed as moderate due to a thin layer of available materials and due to the potential for seepage of the embankment materials. Secondary soils mapped in the area of the proposed embankment consist of soils of the Blazon-Shinbara complex (Soil No. 235). The composition of this complex is 45 percent Blazon loam, 30 percent Shinbara loam. Blazon soils are generally classified as a loam to clay loam soil exhibiting medium plasticity. Shinbara soils are generally classified as a loam to clay loam soil exhibiting low plasticity. Embankment limitations for the secondary soils are listed as severe due to a thin layer of available embankment materials. The secondary soils are located approximately 200 feet east of the proposed embankment location. Geologic mapping indicates that the area is mapped as the Niobrara formation. The Niobrara formation consists of light colored limestone and gray to yellow limy shale.

SOIL PROPERTIES

PRIMARY SOILS

<table>
<thead>
<tr>
<th></th>
<th>USDA Texture</th>
<th>USCS</th>
<th>AASHTO</th>
<th>LL</th>
<th>PI</th>
<th>Permeability (in/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echemoor</td>
<td>clay loam</td>
<td>CL</td>
<td>A-6</td>
<td>30-40</td>
<td>15-20</td>
<td>0.6-2.0</td>
</tr>
<tr>
<td>Haggerty</td>
<td>loamy</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

R - 3": 0
P #4: 75-100
P #10: 75-100
P #40: 70-100
P #200: 50-80
SOIL PROPERTIES, Continued

SECONDARY SOILS

Blazon
USDA Texture: clay loam
USCS: CL
AASHTO: A-6
LL: 35-40
PI: 10-20
Permeability (in/hr): 0.6-2.0

Shinbara
USDA Texture: clay loam
USCS: CL
AASHTO: A-6
LL: 35-40
PI: 10-20
Permeability (in/hr): 0.2-0.6

RANKING CRITERIA

Foundation Suitability: Good
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Good
Availability of Primary Embankment Soils: Good
Availability of Secondary Embankment Soils: Fair

| Material Suitability/Availability Rank | 4 |
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consist of alluvial and colluvial deposits of clay, silt, sand and gravel. A sample collected from the proposed abutment area consisted of a clayey to silty sand with gravel. Cobbles and some boulders were also observed in the area of the abutment sample. A sample collected from the channel area consisted of a highly organic, dark brown to dark gray, sandy clay to clayey sand. Surficial soil mapping indicates that the primary soils in the area consist of soils of the Shinbara-Blazon-Rock outcrop complex (Soil No. 252). The composition of this soil is 40 percent Shinbara loam and 30 percent Blazon loam and 15 percent rock outcrop. Shinbara soils are generally classified as a loam to clay loam soil exhibiting low plasticity. Blazon soils are generally classified as a loam to clay loam soil exhibiting medium plasticity. Embankment limitations are listed as severe due to a thin layer of available embankment materials. Secondary soils mapped near the proposed embankment are mapped as Wellsville gravelly loam (Soil No. 1102). However, we were unable to determine specific soil properties for this soil, nor are there any embankment limitations listed for this secondary soil. The secondary soils are located approximately 250 feet north west of the proposed embankment. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
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</thead>
<tbody>
<tr>
<td>Shinbara</td>
<td></td>
</tr>
<tr>
<td>USDA Texture:</td>
<td>clay loam</td>
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<tr>
<td>USCS:</td>
<td>CL</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-6</td>
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<td>LL:</td>
<td>35-40</td>
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<tr>
<td>PI:</td>
<td>10-20</td>
</tr>
<tr>
<td>Permeability (in/hr):</td>
<td>0.2-0.6</td>
</tr>
<tr>
<td>Blazon</td>
<td></td>
</tr>
<tr>
<td>USDA Texture:</td>
<td>clay loam</td>
</tr>
<tr>
<td>USCS:</td>
<td>CL</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-6</td>
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<tr>
<td>LL:</td>
<td>35-40</td>
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<tr>
<td>PI:</td>
<td>10-20</td>
</tr>
<tr>
<td>Permeability (in/hr):</td>
<td>0.6-2.0</td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued
SECONDARY SOILS
Wellsville
USDA Texture: gravelly loam
USCS: N/A
AASHTO: N/A
LL: N/A
PI: N/A
Permeability (in/hr): N/A

RANKING CRITERIA

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Foundation Suitability:</td>
<td>Fair</td>
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<tr>
<td>Suitability of Primary Embankment Soils:</td>
<td>Fair</td>
</tr>
<tr>
<td>Suitability of Secondary Embankment Soils:</td>
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<tr>
<td>Availability of Primary Embankment Soils:</td>
<td>Good</td>
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<tr>
<td>Availability of Secondary Embankment Soils:</td>
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</table>

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
</tr>
</thead>
</table>

INBERG-MILLER ENGINEERS
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of a light brown, fine sandy clay to fine sandy silt. A sample collected from the proposed left abutment area consisted of 2 feet of light brown, fine sandy silt overlying a light brown, fine sandy clay to clayey sand. The sand content appeared to increase with depth. A sample collected from the channel area was similar to the abutment sample, but contained 1 foot of fine sandy silt overlying the fine sandy clay to clayey fine sand. Surficial soil mapping indicates that the primary soils in the area of the proposed embankment consist of soils of the Monte-Clowas complex (Soil No. 320). We were unable to determine the composition of this complex. Monte soils are a silty loam soil exhibiting low plasticity. No specific soil properties were available for Clowas soils. However, Clowas soils are a considered a loamy soil. Embankment limitations are listed as severe due to the susceptibility of the embankment materials to piping. Secondary soils mapped in the area of the proposed embankment consist of soils of the Littsan Variant-Dunkle complex (Soil No. 317) located approximately 300 feet northwest of the proposed embankment, soils of the Monte Alkali-Debone complex (Soil No. 313) located approximately 500 feet southeast of the proposed embankment and soils of the Harterton-Garsid-Haturmus complex (Soil No. 310) located approximately 500 feet southeast of the proposed embankment. Littsan Variant-Dunkle soils are generally considered to be a sandy loam soil exhibiting little to no plasticity. Monte Alkali-Debone soils are generally considered to be loam to clay loam soil exhibiting low to medium plasticity and Harterton-Garsid-Haturmus soils are loam to clay loam soils formed from the residuum of shale. The Harterton-Garsid-Haturmus soils exhibit low to medium plasticity. Embankment limitations for the secondary soils are listed as severe due to the susceptibility to piping and excess seepage and due to a thin layer of available materials. Geologic mapping indicates that the embankment area is mapped as alluvium and colluvium. Alluvium and colluvium soils indicate variable amounts of clay, silt, sand and gravel.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Monte</th>
<th>Clowas</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>loam</td>
<td>loamy</td>
</tr>
<tr>
<td>USCS:</td>
<td>ML</td>
<td>N/A</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-4</td>
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<tr>
<td>LL:</td>
<td>30-40</td>
<td>N/A</td>
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<tr>
<td>PI:</td>
<td>5-10</td>
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<tr>
<td>Permeability (in/hr):</td>
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<td>N/A</td>
</tr>
</tbody>
</table>

INBERG-MILLER ENGINEERS
## SOIL PROPERTIES, Continued

### SECONDARY SOILS

#### Littsan Variant
- **USDA Texture:** sandy loam
- **USCS:** SM
- **AASHTO:** A-2
- **LL:** 20-30
- **PI:** NP-5
- **Permeability (in/hr):** 2.0-6.0

#### Dunkle
- **USDA Texture:** sandy
- **USCS:** N/A
- **AASHTO:** N/A
- **LL:** N/A
- **PI:** N/A
- **Permeability (in/hr):** N/A

#### Harterton
- **USDA Texture:** loam
- **USCS:** CL-ML, ML
- **AASHTO:** A-4
- **LL:** 25-30
- **PI:** 5-10
- **Permeability (in/hr):** 0.6-2.0

#### Garsid
- **USDA Texture:** loam
- **USCS:** CL-ML, ML
- **AASHTO:** A-4
- **LL:** 25-30
- **PI:** 5-10
- **Permeability (in/hr):** 0.6-2.0

#### Haturmus
- **USDA Texture:** clay loam
- **USCS:** CL
- **AASHTO:** A-6
- **LL:** 25-35
- **PI:** 10-15
- **Permeability (in/hr):** 0.6-2.0
RINER 28

RANKING CRITERIA

Foundation Suitability: Poor
Suitability of Primary Embankment Soils: Poor
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Poor

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>2</th>
</tr>
</thead>
</table>
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of a brown silty fine sand with boulders and cobbles. A sample collected from the channel area consists of 4 feet of organic, clayey fine sand, with the sand content increasing with depth. A sample collected from the proposed abutment area consisted of 1.5 feet of a light brown, silty fine sand with gravel, with auger refusal being met at 1.5 due to rocky conditions. Surficial soil mapping indicates that the primary soils in the area of the proposed embankment consist of soils of the Blackhall-Peyton complex (Soil No. 1443). The composition of this complex was not able to be determined. Blackhall soils are generally considered to be a sandy loam soil exhibiting little to no plasticity. Peyton soils are generally classified as a silty sand exhibiting no plasticity. Embankment limitations are listed as moderate to severe due to a thin layer of available embankment materials and due to the susceptibility of the embankment materials to piping. Secondary soils mapped in the area of the proposed embankment consist of soils of the Pagoda complex (Soil No. 1446). Pagoda soils are generally classified as a clay loam exhibiting medium to high plasticity. The Pagoda soils are located approximately 1,000 feet to the northwest and 500 feet to the southeast, on each side of the stream channel. Embankment limitations for the secondary soils are listed as moderate due to the susceptibility of the materials to piping and due to the difficulty in compacting the materials. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

**PRIMARY SOILS**

**Blackhall**

|-----------------|------------|----------|----|---------|-----|-------|-------|---------|----|--------------------------|

**Peyton**

|-----------------|-------------------|------|----|---------|----------|-------|-----|---------|----|--------------------------|
SAVERY 4

SOIL PROPERTIES, Continued
SECONDARY SOILS
Pagoda
USDA Texture: clay loam
USCS: CL
AASHTO: A-7
LL: 40-50
PI: 15-25
Permeability (in/hr): 0.06-0.2

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Very Poor
Suitability of Secondary Embankment Soils: Good
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Poor

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>2</th>
</tr>
</thead>
</table>
LEGEND

- SOIL BOUNDARY
- RESERVOIR HWL
- CONTOUR LINE (20' INTERVAL)
- STREAM CHANNEL

PRIMARY

BLACKHALL-PEYTON COMPLEX
1443 BLACKHALL SANDY PEYTON LOAM

SECONDARY

1446 PAGODA LOAM
BLAZON-CHAPERTON-ROCK OUTCROP COMPLEX
40% BLAZON LOAM
20% CHAPERTON LOAM
20% ROCK OUTCROP
BLAZON-SHINBARA-RENTSAC COMPLEX
50% BLAZON CLAY LOAM
30% SHINBARA LOAM
20% RENTSAC CHANNERY SANDY LOAM
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consist of a brown to gray sandy clay with some cobbles and boulders. Erosional cuts in the area of the proposed embankment indicate the subsoils consist of a weathered shale and sandstone. A sample collected from the proposed abutment area consisted of 2.5 feet of brown, silty sand overlying a light brown, sandy clay to clayey sand. A sample collected from the channel consisted of interbedded layers of a silty fine sand and a sandy clay. Auger refusal was met at 3.5 and 2.5 feet in the abutment and channel samples, respectively. Surficial soil mapping indicates that the proposed abutment lies near the boundary of two soils types, the Pagoda complex (Soil No. 1446) and a soil type with only the soil taxonomy description of Cumulic Haploborolls (Soil No. 1467). Pagoda soils are generally classified as a clay loam exhibiting medium to high plasticity. Cumulic Haploborolls are generally a loamy soil, however, no other specific soil properties are listed. The secondary soils shown in the area of the proposed embankment consist of soils of the Blackhall-Peyton complex (Soil No. 1443). These secondary soils are generally classified as a sandy loam exhibiting little to no plasticity. The secondary soils are located approximately 300 feet northwest of the proposed embankment. Embankment limitations for the secondary soils are listed as moderate to severe due to the susceptibility of the materials to piping and due to only a thin layer of available materials. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>Pagoda</th>
<th>Cumulic Haploborolls</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>clay loam</td>
<td>loamy</td>
</tr>
<tr>
<td>USCS:</td>
<td>CL</td>
<td>N/A</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-7</td>
<td>N/A</td>
</tr>
<tr>
<td>LL:</td>
<td>40-50</td>
<td>N/A</td>
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<tr>
<td>PI:</td>
<td>15-25</td>
<td>N/A</td>
</tr>
<tr>
<td>Permeability (in/hr):</td>
<td>0.06-0.2</td>
<td>N/A</td>
</tr>
<tr>
<td>R - 3&quot;:</td>
<td>0</td>
<td>N/A</td>
</tr>
<tr>
<td>P #4:</td>
<td>100</td>
<td>N/A</td>
</tr>
<tr>
<td>P #10:</td>
<td>100</td>
<td>N/A</td>
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<tr>
<td>P #40:</td>
<td>95-100</td>
<td>N/A</td>
</tr>
<tr>
<td>P #200:</td>
<td>70-95</td>
<td>N/A</td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

SECONDARY SOILS

Blackhall
USDA Texture: sandy loam
USCS: SM
AASHTO: A-4
LL: 15-20
PI: 0-5
Permeability (in/hr): 2.0-6.0

Peyton
USDA Texture: loamy coarse sand
USCS: SM
AASHTO: A-1, A-2
LL: ---
PI: NP
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Fair

Material Suitability/Availability Rank | 3
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of light brown, silty sand with gravel and some cobbles and boulders. A sample collected from the proposed abutment consisted of a light brown, silty sand with gravel. Auger refusal was met at 1 foot due to the rocky conditions. A sample collected from the channel area consisted of an organic, brown, silty sand to sandy silt and possibly some clay. Auger refusal was met at 2 feet in the channel sample due to rocky conditions. A small embankment was observed just down stream of the proposed embankment location. The embankment height was approximately 5 feet and appeared to be constructed of the channel materials. It appears that the embankment was performing satisfactorily, but only a small amount of water was ponded behind the embankment. Surficial soil mapping indicates that the proposed embankment lies near the boundary of two primary soils, soils of the Evanston complex (Soil No. 912) and soils of the Blackhall-Peyton complex (Soil No. 1443). Evanston soils are generally classified as a clay loam exhibiting medium plasticity. The composition of the Blackhall-Peyton complex was not able to be determined. Blackhall soils are generally classified as a sandy loam soil exhibiting little to no plasticity. Peyton soils are generally classified as a silty sand exhibiting no plasticity. Embankment limitations for the primary soils are listed as moderate to severe due to the susceptibility of the embankment materials to piping and due to a thin layer of available embankment materials. Secondary soils mapped in the area consist of soils of the Pagoda complex (Soil No. 1446) and soils of the Rock River-Ryark Variant complex. Pagoda soils are generally classified as a clay loam exhibiting medium to high plasticity. The Pagoda soils are located approximately ½-mile west of the proposed embankment. The Rock River-Ryark Variant soils are generally classified as sandy loam soils exhibiting little to no plasticity. The Rock River-Ryark Variant soils are located approximately ½-mile east of the proposed embankment. Due to the distance to the secondary soils, the secondary soils are not considered a likely source of embankment materials. Therefore, soil properties for the embankment soils are not listed below. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evanston</strong></td>
</tr>
<tr>
<td>USDA Texture: clay loam</td>
</tr>
<tr>
<td>R - 3&quot;: 0-5</td>
</tr>
<tr>
<td><strong>Blackhall</strong></td>
</tr>
<tr>
<td>R - 3&quot;: 0-5</td>
</tr>
</tbody>
</table>
SOIL PROPERTIES, Continued

PRIMARY SOILS, Continued

Peyton

USDA Texture: loamy coarse sand
USCS: SM
AASHTO: A-1, A-2
LL: ---
PI: NP
Permeability (in/hr): 2.0-6.0

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Good
Suitability of Secondary Embankment Soils: Poor
Availability of Primary Embankment Soils: Good
Availability of Secondary Embankment Soils: Very Poor

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>4</th>
</tr>
</thead>
</table>
SMILEY DRAW 3

SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of a brown, sandy clay to clayey sand with gravel and cobbles. Erosional cuts in the area of the proposed embankment indicate that the underlying bedrock materials consist of weathered shales. Samples collected from the proposed abutment area and the channel were consistent with the surficial soils. Auger refusal was met at 1 foot due to the rocky conditions. Surficial soil mapping indicates that all surficial soil within a 2-mile radius of the proposed embankment site consist of soils of the Pinelli-Boettcher complex (Soil No. 296). The composition of the complex is 60 percent Pinelli clay loams and 25 percent Boettcher clay loam. Pinelli clay loam soils exhibit medium to high plasticity and generally contain some sand. Boettcher clay loam soils are very similar to Pinelli soils, namely a sandy, medium to high plasticity clay. Embankment limitations are listed as moderate due to the susceptibility of the materials to piping and due to only a thin layer of available materials. Geologic mapping shows this area to be mapped as Lewis Shale. Lewis Shale is classified as gray marine shale containing many gray and brown lenticular concretion-rich sandstone beds.

SOIL PROPERTIES

PRIMARY SOILS

Pinelli

- USDA Texture: clay
- USCS: CL, CH
- AASHTO: A-6, A-7
- LL: 35-60
- PI: 30-45
- Permeability (in/hr): 0.06-0.2

Boettcher

- USDA Texture: clay
- USCS: CL, CH
- AASHTO: A-6, A-7
- LL: 35-60
- PI: 30-45
- Permeability (in/hr): 0.06-0.2

RANKING CRITERIA

Foundation Suitability: Good
Suitability of Primary Embankment Soils: Very Good
Suitability of Secondary Embankment Soils: Very Good
Availability of Primary Embankment Soils: Very Good
Availability of Secondary Embankment Soils: Very Good

Material Suitability/Availability Rank 5
SOIL CONDITIONS
The surficial soils observed during the site visit consisted of a brown, sandy clay to clayey sand. Rock outcropping in the area indicate that the bedrock consists of weathered sandstone. A sample collected from the proposed abutment area consisted of a light brown, silty fine sand. Auger refusal was met at 1 foot due to rocky conditions. A sample collected from the channel consisted of a dark brown, highly organic sandy clay to clayey sand. Water was encountered at a depth of 1 foot. The channel sample was only able to be advanced to a depth of 3 feet due to the shallow water conditions. Surficial soil mapping indicates that the primary soils in the area of the proposed embankment consist of soils of the Forelle-Patent complex (Soil No. 233). The composition of this complex is 40 percent Forelle loam and 30 percent Patent loam. The Forelle soils are a clay loam soil exhibiting low to medium plasticity. The Patent soils are a loam soil exhibiting low plasticity. Generally, the Patent soils are classified as a low plasticity clay or silt. Embankment limitations are listed as slight to severe due to the piping potential of the embankment soils. Secondary soils in the area of the proposed embankment consist of soils of the Shinbara-Blazon-Rock outcrop complex, soils of the Echemoor-Vabem complex (Soil No. 119) and soils of the Blazon-Shinbara-Rentsac complex (Soil No. 563). Each of these secondary soil types are generally a loam to clay loam soil with varying amounts of sand and gravel. However, the location of the proposed embankment is in a deep draw with each of the secondary soils being located along the crests of the draw. Embankment limitations for the secondary soils are listed as severe due to the thin layer of available embankment materials and due to the susceptibility of the embankment soils to piping. Additionally, accessibility to the secondary soils for embankment construction would be very difficult, due to their relation to the proposed embankment location. Geologic mapping shows the area to be mapped as a portion of the Rawlins Uplift of the Mesaverde Group. The Rawlins Uplift consists of 4 separate formations which are similar in composition, primarily consisting of soft sandstone and sandy shale with some thin coal beds. We were unable to determine the exact formation of the Rawlins Uplift for this area.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
<th>FORELLE</th>
<th>PATENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>USDA Texture:</td>
<td>clay loam</td>
<td>loam</td>
</tr>
<tr>
<td>USCS:</td>
<td>CL</td>
<td>CL, CL-ML</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-4, A-6</td>
<td>A-4, A-6</td>
</tr>
<tr>
<td>LL:</td>
<td>25-40</td>
<td>20-35</td>
</tr>
<tr>
<td>PI:</td>
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<td>3-18</td>
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<td>Permeability (in/hr):</td>
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<td>0.6-2.0</td>
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R - 3": 0-10, P #4: 85-100, P #10: 85-100, P #40: 80-100, P #200: 55-80
## SOIL PROPERTIES, Continued

### SECONDARY SOILS

#### Shinbara

<table>
<thead>
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</tr>
</thead>
<tbody>
<tr>
<td>USCS:</td>
<td>CL</td>
<td>P #4:</td>
<td>80-100</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-6</td>
<td>P #10:</td>
<td>80-100</td>
</tr>
<tr>
<td>LL:</td>
<td>35-40</td>
<td>P #40:</td>
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<tr>
<td>PI:</td>
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<td>P #200:</td>
<td>60-75</td>
</tr>
<tr>
<td>Permeability (in/hr):</td>
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#### Blazon

<table>
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<th>0-5</th>
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</thead>
<tbody>
<tr>
<td>USCS:</td>
<td>CL</td>
<td>P #4:</td>
<td>80-100</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-6</td>
<td>P #10:</td>
<td>80-100</td>
</tr>
<tr>
<td>LL:</td>
<td>35-40</td>
<td>P #40:</td>
<td>75-95</td>
</tr>
<tr>
<td>PI:</td>
<td>10-20</td>
<td>P #200:</td>
<td>60-75</td>
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<tr>
<td>Permeability (in/hr):</td>
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</table>

#### Rentsac

<table>
<thead>
<tr>
<th>USDA Texture:</th>
<th>channery sandy loam</th>
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<th>0-5</th>
</tr>
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<tbody>
<tr>
<td>USCS:</td>
<td>GM</td>
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</tr>
<tr>
<td>AASHTO:</td>
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<td>---</td>
<td>P #40:</td>
<td>15-30</td>
</tr>
<tr>
<td>PI:</td>
<td>NP</td>
<td>P #200:</td>
<td>10-25</td>
</tr>
<tr>
<td>Permeability (in/hr):</td>
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<td></td>
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</table>

#### Echemoor

<table>
<thead>
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<th>0</th>
</tr>
</thead>
<tbody>
<tr>
<td>USCS:</td>
<td>CL</td>
<td>P #4:</td>
<td>75-100</td>
</tr>
<tr>
<td>AASHTO:</td>
<td>A-6</td>
<td>P #10:</td>
<td>75-100</td>
</tr>
<tr>
<td>LL:</td>
<td>30-40</td>
<td>P #40:</td>
<td>70-100</td>
</tr>
<tr>
<td>PI:</td>
<td>15-20</td>
<td>P #200:</td>
<td>50-80</td>
</tr>
<tr>
<td>Permeability (in/hr):</td>
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<td></td>
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</table>

#### Vabem

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<thead>
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<td>AASHTO:</td>
<td>A-4</td>
<td>P #10:</td>
<td>85-100</td>
</tr>
<tr>
<td>LL:</td>
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<td>PI:</td>
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<td>Permeability (in/hr):</td>
<td>0.2-0.6</td>
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<td></td>
</tr>
</tbody>
</table>

---

INBERG-MILLER ENGINEERS
SAVERY 27

RANKING CRITERIA

Foundation Suitability: Fair
Suitability of Primary Embankment Soils: Fair
Suitability of Secondary Embankment Soils: Very Poor
Availability of Primary Embankment Soils: Fair
Availability of Secondary Embankment Soils: Very Poor

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
</tr>
</thead>
</table>

INBERG-MILLER ENGINEERS
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of gravel, cobbles and boulders in a silty to clayey sand matrix. Samples were collected from the proposed abutment area and from the existing channel. The samples were consistent with the surficial soils, with near surface auger refusal in the abutment sample and auger refusal at 1 foot in the channel sample. However, the channel sample was darker in color and appeared to contain more clay content than the abutment sample. An existing embankment has been constructed around a spring near the proposed embankment location. This existing embankment appears to be constructed of the clayey soils encountered within the channel sample. The existing embankment was impounding water but has experienced significant erosion on the downstream side of the embankment, likely indicating problems with piping of the embankment materials. Surficial soil mapping of the area indicates that the primary soils in the area of the proposed embankment consist of soils of the Peyton-Hesperus-Evanston complex (Soil No. 1442). The composition of this complex was not able to be determined. Peyton soils are generally classified as a silty sand exhibiting no plasticity. Hesperus soils are generally considered to be a clay loam soil exhibiting medium plasticity. Evanston soils are generally classified as a clay loam exhibiting medium plasticity. Embankment limitations for the primary soils are listed as moderate to severe due to the susceptibility of the embankment soils to piping. Secondary soils mapped in the area of the proposed embankment consist of soils mapped as Haggerty loams (Soil No. 1469) and soils mapped as the Peyton-Evanston complex (Soil No. 1441). The Haggerty loam soils are located approximately 250 feet southeast of the proposed embankment, however, we were unable to determine specific soil properties for the Haggerty loam soils. Peyton-Evanston soils are located approximately 400 feet north of the proposed embankment location. Peyton-Evanston soils are generally considered to be a loamy coarse sand with some clay loams. Soil properties for the Peyton-Evanston soils are included the primary soils below. Embankment limitations for the secondary soils are listed as moderate to severe due to the susceptibility of the embankment materials to piping and excess seepage. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peyton</td>
</tr>
<tr>
<td>USDA Texture:</td>
</tr>
<tr>
<td>USCS:</td>
</tr>
<tr>
<td>AASHTO:</td>
</tr>
<tr>
<td>LL:</td>
</tr>
<tr>
<td>PI:</td>
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<tr>
<td>Permeability (in/hr):</td>
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<tr>
<td>R - 3&quot;:</td>
</tr>
<tr>
<td>P #4:</td>
</tr>
<tr>
<td>P #10:</td>
</tr>
<tr>
<td>P #40:</td>
</tr>
<tr>
<td>P #200:</td>
</tr>
</tbody>
</table>
**SOIL PROPERTIES.** Continued  
**PRIMARY SOILS.** Continued  

**Hesperus**  
USDA Texture: clay loam  
USCS: CL  
AASHTO: A-6  
LL: 30-40  
PI: 10-20  
Permeability (in/hr): 0.6-2.0  

**Evanston**  
USDA Texture: clay loam  
USCS: CL  
AASHTO: A-6  
LL: 25-35  
PI: 10-15  
Permeability (in/hr): 0.6-2.0  

**SECONDARY SOILS**  
**Haggerty**  
USDA Texture: loamy  
USCS: N/A  
AASHTO: N/A  
LL: N/A  
PI: N/A  
Permeability (in/hr): N/A  

**RANKING CRITERIA**  
Foundation Suitability: Fair  
Suitability of Primary Embankment Soils: Fair  
Suitability of Secondary Embankment Soils: Poor  
Availability of Primary Embankment Soils: Fair  
Availability of Secondary Embankment Soils: Poor  

| Material Suitability/Availability Rank | 3 |
SOIL CONDITIONS

The surficial soil conditions observed during the site visit consisted of silty to clayey fine sand. A sample collected from the proposed abutment area consisted of 3 feet of a dark brown, silty to clayey fine sand with auger refusal at 3 feet. A sample collected from the channel consisted of 2 feet of highly organic, fine sandy clay over a light brown, silty clay to 3 feet. It is anticipated that the silty clay soils encountered at 2 feet in the channel sample would be a good embankment material. Surficial soil mapping of the area indicates that the primary soils in the area of the proposed embankment consist of soils of the Peyton-Evanston complex (Soil No. 1441). The composition of the complex was not able to be determined. Peyton soils are generally considered to be a loamy coarse sand exhibiting little to no plasticity. The Evanston soils are a clay loam soil exhibiting moderate plasticity. Embankment limitations for the Peyton-Evanston complex are listed as moderate due to the potential for piping of the embankment soils. Secondary soils mapped in the area of the proposed embankment consist of soils of the Blazon-Shinbara-Rentsac complex (Soil No. 563). The composition of these secondary soils is 30 percent Blazon clay loam, 30 percent Shinbara loam and 20 percent Rentsac channery sandy loam. Generally this soil complex is considered to be a low plasticity clayey soil with some gravel. The secondary soils are located approximately 250 east of the proposed embankment. Embankment limitations for the secondary soils is listed as severe due to a thin layer of available materials. Geologic mapping indicates that the area is mapped as Miocene Rock. Miocene rocks within the Rawlins area are classified as a white, soft, tuffaceous sandstone.

SOIL PROPERTIES

<table>
<thead>
<tr>
<th>PRIMARY SOILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peyton</td>
</tr>
<tr>
<td>USDA Texture: loamy coarse sand</td>
</tr>
<tr>
<td>USCS:         SM</td>
</tr>
<tr>
<td>AASHTO:       A-1, A-2</td>
</tr>
<tr>
<td>LL:           ---</td>
</tr>
<tr>
<td>PI:           NP</td>
</tr>
<tr>
<td>Permeability (in/hr): 2.0-6.0</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Evanston</td>
</tr>
<tr>
<td>USDA Texture: clay loam</td>
</tr>
<tr>
<td>USCS:         CL</td>
</tr>
<tr>
<td>AASHTO:       A-6</td>
</tr>
<tr>
<td>LL:           25-35</td>
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<tr>
<td>PI:           10-15</td>
</tr>
<tr>
<td>Permeability (in/hr): 0.6-2.0</td>
</tr>
</tbody>
</table>
**SOIL PROPERTIES**, Continued

### SECONDARY SOILS

**Blazon**
- USDA Texture: clay loam
- USCS: CL
- AASHTO: A-6
- LL: 35-40
- PI: 10-20
- Permeability (in/hr): 0.6-2.0

**Shinbara**
- USDA Texture: clay loam
- USCS: CL
- AASHTO: A-6
- LL: 35-40
- PI: 10-20
- Permeability (in/hr): 0.2-0.6

**Rentsac**
- USDA Texture: channery sandy loam
- USCS: GM
- AASHTO: A-1
- LL: ---
- PI: NP
- Permeability (in/hr): 2.0-6.0

### RANKING CRITERIA

- Foundation Suitability: Fair
- Suitability of Primary Embankment Soils: Fair
- Suitability of Secondary Embankment Soils: Fair
- Availability of Primary Embankment Soils: Good
- Availability of Secondary Embankment Soils: Fair

<table>
<thead>
<tr>
<th>Material Suitability/Availability Rank</th>
<th>3</th>
</tr>
</thead>
</table>

*INBERG-MILLER ENGINEERS*
APPENDIX G

WYOMING WETLAND BANKING SUMMARY
WETLAND BANKING

General

In 1991, the Wyoming Legislature passed the Wyoming Wetlands Act. The Act was further amended and refined in the 1994 legislative session. Specifically, Wyoming Statutes 35-11-308 through 35-11-311 provide the legislative authority to establish the Wyoming Wetland Bank. The purpose of the Wyoming Wetland Bank is to facilitate wetland mitigation required by existing and future federal, state or local regulations. The legislation clearly recognizes the ecological importance of wetlands and their inherent values. The intent is to maintain those values for present and future generations. The procedures and programs developed to achieve this goal, should not erode private property rights, water rights, or economic opportunity.

Eligibility, Deposits and Credits

Man-made wetlands which were created or enhanced after July 1, 1991 are eligible for deposit in the Statewide Wetland Bank, subject to evidence of the actual improvements that were made. Any person wishing to deposit wetlands in the State Bank must notify the Department of Environmental Quality (DEQ) before beginning the creation, restoration or enhancement project. An on-site pre-construction evaluation will be made by the DEQ or their designated representative. The purpose of this inspection will be to document the pre-project condition so a calculation of actual post-project credits can be made.

Wyoming water rights are required for the water supply needed for the development or enhancement of wetland areas. These water rights are administered in accordance with Wyoming state law and water supply is not guaranteed. Water will be available for the wetlands as determined by the priority date of the water right. Water supply for wetlands is considered a beneficial use by the SEO but no preference over other uses is recognized (i.e., the beneficial use associated with wetland enhancement will not be preferred over municipal, agricultural, or industrial water rights with the same priority date). Along with a request for deposit, the applicant must provide proof of legal water rights.

Once construction is complete, a post construction inspection will be made at the request of the applicant. The purpose of this inspection is to document the actual wetland improvements made. The amount of eligible credit (acreage) will then be calculated and deposited in the bank.

Because wetlands are successional systems, the amount of credit deposited might not be the amount of credit that is available at the time of withdrawal. The credits deposited in the bank only
represent the amount of wetland acreage at the date of deposit. Furthermore, the calculated size and value of the existing wetland at the time of the pre-project evaluation will serve as the baseline for that specific site until credits are used for mitigation.

**Use of Wetland Credits for Mitigation (Withdrawal)**

Since all wetland credits are attached to the land, credit can only be withdrawn from the bank by the landowner in accordance with any third-party agreements attached to the deed. Proof of ownership must accompany all requests for withdrawal. Additionally, credits can only be withdrawn for use as mitigation as required by federal, state, or local laws and ordinances. Once credit has been withdrawn for use as mitigation, the area will be treated as a “natural wetland” and all existing wetland regulation will apply.

**Limitations**

With respect to the proposed construction of stock ponds, certain limitations exist with respect to wetland credits. The primary limitations are geographic and ecologic. The geographic limitation confines the use of banked credits to the Wyoming river basin in which the impacts will occur. For this Level II project, the geographic limitation confines the use of banked wetland credits for use as mitigation to the Green River and Little Snake River Basin. The ecologic limitation provides for the withdrawal of credits for mitigation of unrelated projects only within the same biotic region and for impacts to the same wetland system and class (Cowardin System). For the purposes of wetland banking, there are three broadly defined biotic regions: Mountain Range; Plains; or High Desert.

**Wetland Banking Summary**

Since construction of the stock ponds and reservoirs may create wetlands that may be eligible for the State Wetland Bank, the WWDC may have an interest in obtaining ownership for these wetland banking credits. The credits may be beneficial in terms of mitigation associated with future water development projects. Ownership of the wetland banking credits belongs to the landowner; consequently, a legal agreement will be required to transfer the ownership of these credits to the District and ultimately the WWDC.

The limitations associated with the wetland banking credits reduce their potential value. Geographically, the wetland credits must be utilized within the region in which the credits were derived. Conversations with Mr. Matt Bilodeau from the COE Wyoming Regulatory Office in
Cheyenne, Wyoming indicate that utilization of these credits could be further restricted to the watershed in which the credits were derived. This means that credits generated within the Little Snake River Basin may be limited to mitigation for projects within the Little Snake River Basin. With respect to the ecologic limitation, credits can only be utilized as mitigation if they are associated with a project within the same biotic region.

To date, no wetland banking credits have been withdrawn as mitigation for a construction project within the State of Wyoming. The use of wetland banking credits as mitigation for future projects has not been tested; consequently, the viability of this process is unknown until a project has been identified and successfully passed the scrutiny of the COE/EPA permitting review process.

Finally, it may not be prudent to invest significant resources to facilitate wetland development at each stock pond/reservoir site. The potential for success is relatively low at some sites due to environmental factors such as low precipitation, high evaporation, possibly high sedimentation rates, sandy soils and seepage, topography, and the life expectancy of the impoundment(s). These factors tend to inhibit the formation of self-sustaining wetlands suitable for banking.
APPENDIX H

RESERVOIR PLAN VIEW MAPPING
RESERVOIR STORAGE TABLE

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LEGEND

- RESERVOIR HML
- CONTOUR LINE (2'- INTERVAL)
- STREAM CHANNEL

CROSS SECTION

RESERVOIR OF_
RESERVOIR STORAGE TABLE

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LEGEND
- RESERVOIR HWL
- CONTOUR LINE (20' INTERVAL)
- STREAM CHANNEL

PMPC
118 E. BRIDGE AVE., P.O. BOX 370
SARATOGA, WYOMING 82331
307-326-8301

LITTLESTONE & ANDERSON, INC.
LITTLE SNAKE RIVER BASIN STOCKWATER PONDS
BRIDGER PASS NO. 32
RESERVOIR

DRAWN BY: LMW/JHF
DATE: 5/12/99

SCALE: 1" = 400'

RESERVOIR STORAGE TABLE

ELEVATION AREA STORAGE
7648 0
7660 2.2 12.2
7663 3.9 22.1
CROSS SECTION

LEGEND

RESERVOIR HML

CONTOUR LINE (20\' INTERVAL)

STREAM CHANNEL

RESERVOIR STORAGE TABLE

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## Legend

- Reservoir HWL
- Contour Line (20' interval)
- Stream Channel

## Cross Section

![Cross Section Diagram](image)

**Scale:** 1" = 400'
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**Legend**
- Reservoir HML
- Contour line (20' interval)
- Stream channel

---

**Cross Section**

**Reservoir Storage Table**

Elevation: 6903, 6910, 6925, 6935

Area: 6.5 acres, 14.3 acres

Storage: 22.8 acres-feet, 178.8 acres-feet

**Reservoir**

PMPC Consulting Engineers
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RESERVOIR STORAGE TABLE

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LEGEND

- RESERVOIR HWL
- CONTOUR LINE (20' INTERVAL)
- STREAM CHANNEL

CROSS SECTION NTS

PMPC
CONSULTING ENGINEERS
LEGEND

- - - - RESERVOIR HWL
- - - - CONTOUR LINE (20' INTERVAL)
- - - - STREAM CHANNEL

CROSS SECTION

NTS

RESERVOIR STORAGE TABLE

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PMPC
CONSULTING ENGINEERS

LIDSTONE & ANDERSON, INC.
LITTLE SNARE RIVER BASIN STOCKWATER FONDS
POLE GULCH NO. 27 RESERVOIR

Job No. 775609
File No. R: POLE GULCH
Scale T = 400'
RESERVOIR STORAGE TABLE

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LEGEND

- Reservoir HML
- Contour Line (20' Interval)
- Stream Channel

CROSS SECTION

NTS

SMILEY DRAW NO. 3
RESERVOIR

LITTLE SNAKE RIVER SHINS STOCKWATER PONDS

PMPC
CONSULTING ENGINEERS

LESTONE & ANDERSON, INC.

JOB NO. 71858
FILE NO. 7-18585

SMILEY DRAW NO. 3
RESERVOIR

DRAWN BY: L. A.
DATE: 12-5-87

SHEET

1 OF 1
APPENDIX I

INSTITUTIONAL ISSUES AND PLANNING SUMMARY DOCUMENT
May 12, 1998

Mr. Mike Carnevale
Wyoming Water Development Commission
Herschler Building, 4th Floor
Cheyenne, WY 82002

Re: Little Snake River Basin Water Development Project, Level II

Dear Mike:

I am enclosing 10 copies and one original copy of our report entitled “Policy, Institutional Issues and Planning Summary Document” in support of the referenced project. Your comments have been incorporated into this final report.

If you have any questions related to this report or the recent revisions that we have made, please do not hesitate to call me.

I look forward to hearing from you.

Sincerely,

LIDSTONE & ANDERSON, INC.

Bradley A. Anderson, P.E.
Vice President

BAA/tlt

Enclosure
LITTLE SNAKE RIVER BASIN
LEVEL II PROJECT

POLICY, INSTITUTIONAL ISSUES AND
PLANNING SUMMARY DOCUMENT

Submitted To:

Wyoming Water Development Commission
Herschler Building, 4th Floor
122 West 25th Street
Cheyenne, WY 82002

Submitted By:

Lidstone & Anderson, Inc.
760 Whalers Way, Suite B200
Fort Collins, CO 80525

April 14, 1998
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I. INTRODUCTION

In the fall of 1996 the Wyoming Water Development Commission (WWDC) received an application for Level III funding from the Little Snake River Conservation District (District). The District originally requested a 60% grant, 40% loan totaling $687,500 to fund the construction of 34 small impoundments in the Little Snake River Basin. As proposed by the District, the ponds are to be constructed on several tributaries to the Little Snake River and are intended primarily for livestock watering, rangeland improvement and wildlife habitat enhancement. The District estimated the project would improve 25 ranching operations and 22,400 acres of rangeland.

The WWDC recommended that the application be modified to reflect the completion of a Level II project to determine the feasibility of constructing 34 small impoundments in the Little Snake River Basin. The proposed modification was subsequently approved by the WWDC for funding.

On May 30, 1997 Lidstone & Anderson, Inc. (LA) entered into a contract with the WWDC to provide professional services related to the Little Snake River Basin Small Reservoir Water Development Level II Project. As stated in the contract, the purpose of the Level II project is to complete the conceptual designs and cost estimates for 34 potential reservoir sites ranging in capacity from approximately 5 acre-feet to over 100 acre-feet. The primary purpose of the impoundments is to meet requirements for livestock watering and consequently, improvements to rangeland. Secondary benefits include the potential increase in wildlife habitat, wetland development, and fisheries. The reservoirs are located on lands owned by federal, state and private entities. Figure 1 presents a location map of the 34 potential reservoir sites.

The scope of services for this project consists of: (a) review of proposed reservoir sites; (b) technical analyses of the hydrology, water rights, geotechnical issues, sedimentation and water quality; (c) determination of reservoir service area; (d) evaluation of wetland banking potential; (e) preparation of conceptual designs and cost estimates; (f) identification of necessary permits and environmental studies; and (g) development of a financing plan and completion of a benefit-cost analysis. In addition to this work effort, the WWDC requested that a discussion document be prepared to present information pertinent to the evaluation, conceptual design and funding of future livestock reservoir projects. This report summarizes the results of the work associated with the discussion document.

This document discusses information that is intended to assist the WWDC in determining if this project (or similar projects) are: (a) eligible for WWDC funding; (b) appropriate for the
Figure 1. Location Map
agency to participate in; and (c) a good investment for the State of Wyoming. The document also discusses potential criteria that would have to be satisfied in order for the WWDC to participate in project financing. The items listed below were considered in this evaluation and are summarized in this report.

- Design Criteria
- Permitting Issues
- Wetland Banking
- Evaluation Criteria
- Cursory Review of Operating Criteria
- Legal Review
II. DESIGN AND CONSTRUCTION GUIDELINES

2.1 General

A cursory review of aerial photographs indicated the existence of several previously constructed stock ponds within the Little Snake River Basin. In general, these ponds were designed and constructed by the BLM, District and individual land owners. It is likely that a variety of guidelines were utilized during the design and construction of these stock ponds and reservoirs.

To assist in the design and construction of this Level II project as well as future livestock ponds and reservoirs, preliminary guidelines have been prepared. Several entities publish procedures, guidelines and specifications for the design and construction of these ponds and reservoirs. These entities include the Bureau of Land Management (BLM), Natural Resources Conservation Service (NRCS, formerly the SCS), Bureau of Reclamation (BOR), and State Engineer’s Office (SEO). For the purposes of this document, all impoundments constructed within the State of Wyoming fall under the jurisdiction of the SEO. Consequently, any embankment constructed within Wyoming must comply with the SEO’s rules and regulations.

In reviewing the available information, adherence to the rules and regulations promulgated by the SEO as well as the procedures published by the NRCS in Pond 378 Technical Guide, is recommended. It is noted that the design guidelines documented in Pond 378 Technical Guide are very similar to those design guidelines established by the SEO. The design and construction guidelines presented in this chapter pertain to all structures which meet the following criteria:

1. Failure of the dam will not result in loss of life; in damage to homes, commercial or industrial buildings, main highways or railroads; or result in interruption of the use or service of public utilities. These dams are classified as low hazard structures located in rural or agricultural areas where failure may damage farm buildings, agricultural land, or township and country roads.

2. The effective height of the embankment is less than 35 feet. The effective height of the embankment is defined as the difference in elevation, in feet, between the emergency spillway crest and the lowest point in the cross section taken along the centerline of the embankment.

3. The product of the storage, in acre-feet, times the effective height of the dam is less than 3,000. Storage is the volume in the reservoir below the elevation of the crest of the emergency spillway.
In addition to the above criteria, the site conditions should be such that runoff from the design storm should safely pass through the principal spillway, or the emergency spillway, or a combination of the principal and emergency spillways.

It is important to remember that the SEO classifies dam embankments as either stock ponds (those embankments less than 20 feet in height and capacity less than 20 acre-feet) or reservoirs (embankment height greater than 20 feet or capacity greater than 50 acre-feet). Reservoirs must meet additional permitting requirements per the safety of dam regulations.

2.2 References

The following references were reviewed and evaluated during the preparation of the design and construction guidelines.


2.3 Design Guidelines

The following information summarizes the guidelines for designing a small dam embankment meeting the criteria described in Section 2.1. The design of the dam embankments should be completed or directed by a licensed professional engineer registered in the State of Wyoming. The accountability for the design and construction of the dam embankment should rest with the professional engineer. Please refer to Figure 2 for typical drawings related to the design of the dam embankment.
Figure 2. Typical Design Drawings
Foundation:

- The foundation conditions for any dam embankment should be determined by an adequate subsurface exploration/investigation. The subsurface conditions should be reviewed by a qualified geotechnical engineer to verify that the foundation materials provide adequate support for the given site conditions.

- A cutoff trench should be included to control seepage and piping along the foundation of the embankment. The cutoff trench should extend a minimum of 3 feet into the bedrock materials and should have a minimum width of 12 feet. The cutoff trench should be constructed with a maximum side slope of 1H:1V, and the end slopes should have a maximum slope of 3H:1V. The cutoff trench should be constructed of clayey soils classified as CH or CL according to the Unified Soil Classification System. The cutoff trench should not consist of materials classified as ML, MH, OH, PT, GW, GP, SW and SP.

- Seepage control should be included if: (1) pervious layers are not adequately intercepted by the cutoff trench; (2) seepage creates a swamping condition downstream; (3) such control is necessary to maintain a stable embankment; or (4) special problems require drainage for a stable dam. Alternative seepage control measures include foundation, abutment, or embankment drains; reservoir blanketing with an impervious material; or a combination of these measures.

Earth Embankment:

- The embankments should be constructed of clayey soils classified as CH or CL according to the Unified Soil Classification System. The embankments should not consist of materials classified as ML, MH, OH, PT, GW, GP, SW and SP.

- The embankments should be constructed with upstream slopes of 4H:1V and downstream slopes of 2H:1V.

- The crest width of the embankment should be 1/5th of the height plus 4 feet, but no less than 8 feet; if the embankment serves as a road, the crest width should be a minimum of 16 feet for one-way traffic.

- The freeboard between the crest of the emergency spillway and the dam crest should be a minimum of 5 feet. The minimum freeboard between the dam crest and the emergency spillway flowing full should be 1.5 feet.

Spillways:

- A spillway is required to pass the peak inflow from the design storm event without overtopping the dam embankment. The spillway for the dam embankments may consist of either an emergency spillway, principal spillway or combination of both
emergency and principal spillways. Typically, an emergency spillway will be designed with a small conduit (pipe) serving as the principal spillway to discharge trickle flows. Regardless of the type of spillway, it is recommended that the capacity of the spillway should be sufficient to convey the peak discharge associated with the 50-year, 24-hour storm event.

- The maximum depth of flow in the emergency spillway should not exceed 2.5 feet. Maximum velocity through the spillway should not exceed values in the SCS Engineering Field Manual. Where these values cannot be achieved, the spillway must be stabilized with rock or other stabilization measures.

- Where a principal spillway is utilized in conjunction with an emergency spillway, a minimum diameter of 12 inches is recommended by the NRCS. If the function of the principal spillway is to discharge trickle flows, the minimum diameter of the pipe can be reduced to 8 inches.

2.4 Construction Guidelines

The construction of the reservoir should be directed by a qualified professional engineer registered in the State of Wyoming. The engineer should verify that the site has been adequately stripped and that the foundation has been properly prepared and is consistent with the materials encountered within the subsurface exploration. Additionally, the engineer should verify that the embankment materials are suitable for placement and that the design and construction recommendations have been followed. Accountability for the construction of the dam embankment and spillway facilities in accordance with the contract documents and specifications will rest with the professional engineer.

Site Preparation:

- The surface area to be covered by the embankment, borrow areas and emergency spillway should be thoroughly cleared and stripped of vegetative matter, brush, trees, stumps, roots, loose rocks and other objectionable materials including sand, gravel, silt, and debris in channels within the foundation area.

- Topsoil should be removed and conserved in stockpiles. After construction of the embankment, topsoil should be uniformly placed over cut and fill areas above the high water line with priority to the top and upstream slopes of the dam, spillway, and borrow pits.

- Borrow areas should not be located within 25 feet of the upstream toe of the dam.
**Earth Embankment:**

- After clearing, stripping, bank sloping and excavation have been completed, the foundation and cutoff trench should be scarified to a minim depth of 6 inches. Scarified furrows should be a maximum of 3 feet apart and parallel to the axis of the dam. The scarified surface should be compacted with the first layer of embankment materials.

- Embankment materials should be free of sod, roots, brush, snow, other waste matter and rocks of a shape or size that will interfere with uniform placement of materials in layers of specified thickness. Embankment materials should not be placed when either the materials or the surface on which they will be placed, are frozen or too wet for satisfactory compaction.

- Embankment materials should be placed parallel to the axis of the dam in even, continuous, horizontal layers not more than 8 inches in thickness. The full cross section of the dam should be maintained as each successive layer is placed. Distribution and gradation of materials throughout the earthfill should be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material.

- The embankment materials should be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D698, and within minus 1 percent to plus 3 percent of the optimum moisture content.

### 2.5 Summary

Several agencies have criteria and guidelines for the design and construction of stock ponds and reservoirs. Regardless of the agency which promulgates the criteria or guidelines, they must meet or conform to standard engineering practices associated with the design and construction of stock ponds and reservoirs. Where applicable, the requirements of the SEO with respect to dam safety must be considered.

Given the potential problems with foundation stability, it is recommended that a subsurface exploration program be conducted at every stock pond/reservoir location funded by the State of Wyoming. With respect to the design life of the stock pond or reservoir, the criteria/guidelines should ensure the longevity of the structure for the duration of the loan, as a minimum. If a 25-year construction loan is provided, the facilities should be designed to be operational and functional for 25 years. Finally, all work associated with the design and construction of the stock ponds or reservoirs should be directed or supervised by a licensed engineer registered in the State of Wyoming.
Wyoming. Accountability for the design and construction of the stock pond/reservoir will rest with the professional engineer.

Should no loans be required, it is recommended that the WWDC seek assurance from the District that the structures be maintained for at least 25 years. Further, the structures should be designed and constructed in a manner that will allow for a design life of at least 25 years with minimal maintenance.
III. PERMITTING

3.1 General

Prior to construction of the stock ponds or reservoirs, several permits and/or environmental studies may be required to ensure that construction is completed in compliance with all applicable environmental laws. These requirements fall under the jurisdiction of several federal and state agencies including, but not necessarily limited to the Wyoming Department of Environmental Quality, Wyoming State Engineer's Office, Wyoming State Board of Control, U. S. Bureau of Land Management, U. S. Army Corps of Engineers, State Historic Preservation Office, Wyoming Game and Fish Department and U.S. Fish and Wildlife Service. Compliance with Section 404 of the Clean Water Act involves the majority of the agencies. Other regulations also apply to the construction of the stock ponds or reservoirs including, but not limited to the National Environmental Policy Act (NEPA), National Historic Preservation Act (NHPA), and the Endangered Species Act (ESA). In general, compliance with Section 404 of the Clean Water Act often includes compliance with NEPA, NHPA and the ESA. Consequently, this chapter is devoted to a discussion of compliance with Section 404 of the Clean Water Act.

3.2 Permitting Procedures

Section 404 of the Clean Water Act regulates the placement of dredged or fill material into water of the U.S., including wetlands. If elevated to Level III status, this project would involve the construction of dams across drainages or swales, some of which are likely to be waters of the U.S. and may contain wetlands. Consequently, construction of the stock ponds or reservoirs would require authorization or permits from the Corps of Engineers (COE).

To date, three possible authorization/permitting scenarios have been identified.

- Application of the agricultural exemption.

- Authorization under a Nationwide Permit (NWP). NWP 26 allows placement of dredged or fill material resulting in the disturbance of up to 3.0 acres of waters of the U.S.

- Issuance of an Individual Permit (IP).
To permit the project, the following information should be submitted to the COE for each site (Personal communication with Mr. Chandler Peter, U.S. Army Corps of Engineers, Wyoming Regulatory Office, October and November 1997).

- Proposed stock pond location (map).
- Typical diagrams illustrating stock pond configuration and design characteristics.
- A description of the purpose and need for the stock pond (this description should include the storage capacity and livestock numbers associated with individual ponds; proposals to bank any wetlands created by the project; and opportunities for wildlife habitat improvements, if any).
- Location and acreage of jurisdictional wetlands and water of the U.S. that would be affected by the proposed stock pond.
- Area of inundation or impoundment.

If development of a stock pond would disturb a substantial quantity of wetlands, an analysis of possible alternative locations may be required. Additional information may be required on a case-by-case basis, but the information described above should provide the COE with sufficient data to determine permitting requirements. Once these data have been submitted, a determination of sites which qualify for the agricultural exemption and which may need authorization under a NWP or IP can be determined.

3.3 Applicability of the Agricultural Exemption

Generally, the agricultural exemption permits stock pond construction in waters of the U.S. (33 CFR Part 323.4(a)(3) of the Federal Register, Volume 51, No. 219 dated November 13, 1986). The exemption is only permitted, however, if the sole purpose of the stock pond is for livestock watering ("A pond is only exempt to the size the farmer requires to meet normal farming operations", U.S. Army Corps of Engineers, Omaha District, Regulatory Guidance Letter 95-06 dated February 2, 1996). Consequently, storage capacity of the stock pond design may preclude the application of the agricultural exemption. If the ponds are designed for a storage capacity that is substantially larger than required to support the anticipated number of livestock, it is unlikely that the pond will qualify for the agricultural exemption (Personal communication with Mr. Chandler Peter, November 1997).
In addition to livestock watering, the Little Snake River Conservation District (District) is interested in obtaining wetland banking credits under Wyoming's Statewide Wetland Mitigation Bank for any wetlands that are created by new stock pond construction. The District would also like to promote wildlife use of the ponds as well as fishery enhancement. However, with "multiple use" as a stated objective of pond development (as compared to livestock watering as the sole purpose of the pond), the agricultural exemption may not be applied and Section 404 compliance would require authorization under a NWP or IP.

Given that the District may wish to maximize the potential storage at each site along with providing potential benefits to wildlife, wetlands and fisheries, only a limited number of stock ponds are likely to qualify for the agricultural exemption.

3.4 Nationwide versus Individual Permit

The COE is authorized to approve certain types of projects under a NWP, if the project meets the criteria and general conditions of a given NWP. NWP 26 is frequently used to authorize projects such as stock pond construction in headwater areas and requires that no more than 3.0 acres be disturbed in any waters of the U.S. including wetlands (Joint Public Notice, U.S. Army Corps of Engineers and Wyoming Department of Environmental Quality, "Nationwide Permits", May 7, 1997). On a site-by-site basis, few of the proposed stock ponds would cause this threshold to be exceeded. Thus the project may possibly be permitted by submitting separate, site-by-site applications for coverage under a NWP (i.e., submitting applications for each stock pond/reservoir). However, federal agencies are presently avoiding a "piecemeal approach" to projects and are evaluating the cumulative impacts associated with construction of several projects within a basin or watershed (General Condition 15 to Nationwide Permits as presented in Joint Public Notice, U.S. Army Corps of Engineers and Wyoming Department of Environmental Quality, "Nationwide Permits", May 7, 1997). Consequently, the COE may view the project as consisting of the construction of several stock ponds and an IP would then be required. If an IP is required, a single application could be submitted for construction of all of the stock ponds. Should future stock ponds be required, the IP can be modified and no new permit application would be necessary. Furthermore, maintenance activities associated with stock ponds permitted through an IP may also be allowed (Personal communication with Mr. Chandler Peter, U.S. Army Corps of Engineers, Wyoming Regulatory Office, November 1997).
3.5 Depletions

The proposed construction of stock ponds would result in depletions in the Little Snake River watershed, a situation that the U.S. Fish & Wildlife Service (USFWS) has determined is likely to jeopardize threatened and endangered (T&E) fish species. As a reasonable and prudent alternative to the jeopardy opinion, the USFWS has implemented a fee requirement for any depletions in the basin. For projects that result in depletions of less than 100 acre-feet, the fee is typically waived; the fee for depletions greater than 100 acre-feet is paid during the first year of depletion (Personal communication with Mr. Dave Felley, USFWS, November 1997).

The COE regulations state that no project that is likely to jeopardize T&E species can be permitted under a NWP unless a reasonable and prudent alternative to the jeopardy opinion is implemented. If the USFWS waives the fee requirement or the project proponent pays the depletion fee, a project may be permitted under a NWP; otherwise, an IP would be required. During the review of the permit application, the issue associated with potential impacts of cumulative depletions may be raised by the U.S. Fish & Wildlife Service and may need to be addressed (Personal communication with Mr. Chandler Peter, U.S. Army Corps of Engineers, Wyoming Regulatory Office, November 1997).

3.6 Summary

Based on existing information related to the project that was presented to the representatives of the Wyoming Regulatory Office, it is highly likely that the necessary permits can be obtained to achieve compliance with Section 404 of the Clean Water Act. For Section 404 permitting, the level of effort and expense increase from application of the agricultural exemption to applying for an IP. The number of stock ponds eligible for the agricultural exemption may be limited. It is more likely that a NWP for the majority of the ponds will be required. The limitations associated with General Condition 15 to NWP 26 (impact of single versus multiple projects in a watershed) may limit the submittal of individual applications and may ultimately require that an IP application be submitted. Application for an IP which would encompass construction of all of the proposed stock ponds may be more costly but may also offer advantages with respect to the flexibility to construct additional ponds in the future and may allow for maintenance activities associated with the stock ponds.

Finally, where a federal permit is required (i.e., a NWP or IP) and/or federal land is involved (such as stock ponds located on BLM property), compliance with NEPA, the NHPA and the ESA (as well as other federal, state and local laws) will be triggered. Consequently, construction of stock ponds/reservoirs on BLM land will require completion of an Environmental Assessment (EA). The EA can be completed to encompass all of the proposed stock ponds within the Little Snake River Basin (Personal communication with Mr. Bill Waters, Bureau of Land Management, April 1998).
IV. WETLAND BANKING

4.1 General

In 1991, the Wyoming Legislature passed the Wyoming Wetlands Act. The Act was further amended and refined in the 1994 legislative session. Specifically, Wyoming Statutes 35-11-308 through 35-11-311 provide the legislative authority to establish the Wyoming Wetland Bank. The purpose of the Wyoming Wetland Bank is to facilitate wetland mitigation required by existing and future federal, state or local regulations. The legislation clearly recognizes the ecological importance of wetlands and their inherent values. The intent is to maintain those values for present and future generations. The procedures and programs developed to achieve this goal, should not erode private property rights, water rights, or economic opportunity.

4.2 Eligibility, Deposits and Credits

Man-made wetlands which are created or enhanced after July 1, 1991 are eligible for deposit in the Statewide Wetland Bank, subject to evidence of the actual improvements that were made. Any person wishing to deposit wetlands in the State Bank must notify the Department of Environmental Quality (DEQ) before beginning the creation, restoration or enhancement project. An on-site pre-construction evaluation will be made by the DEQ or their designated representative. The purpose of this inspection will be to document the pre-project condition so a calculation of actual post-project credits can be made.

Wyoming water rights are required for the water supply needed for the development or enhancement of wetland areas. These water rights are administered in accordance with Wyoming state law and water supply is not guaranteed. Water will be available for the wetlands as determined by the priority date of the water right. Water supply for wetlands is considered a beneficial use by the SEO but no preference over other uses is recognized (i.e., the beneficial use associated with wetland enhancement will not be preferred over municipal, agricultural, or industrial water rights with the same priority date). Along with a request for deposit, the applicant must provide proof of legal water rights.

Once construction is complete, a post construction inspection will be made at the request of the applicant. The purpose of this inspection is to document the actual wetland improvements made. The amount of eligible credit (acreage) will then be calculated and deposited in the bank.
Because wetlands are successional systems, the amount of credit deposited might not be the amount of credit that is available at the time of withdrawal. The credits deposited in the bank only represent the amount of wetland acreage at the date of deposit. Furthermore, the calculated size and value of the existing wetland at the time of the pre-project evaluation will serve as the baseline for that specific site until credits are used for mitigation.

4.3 Use of Wetland Credits for Mitigation (Withdrawal)

Since all wetland credits are attached to the land, credit can only be withdrawn from the bank by the landowner in accordance with any third-party agreements attached to the deed. Proof of ownership must accompany all requests for withdrawal. Additionally, credits can only be withdrawn for use as mitigation as required by federal, state, or local laws and ordinances. Once credit has been withdrawn for use as mitigation, the area will be treated as a “natural wetland” and all existing wetland regulation will apply.

4.4 Limitations

With respect to the proposed construction of stock ponds, certain limitations exist with respect to wetland credits. The primary limitations are geographic and ecologic. The geographic limitation confines the use of banked credits to the Wyoming river basin in which the impacts will occur. For this Level II project, the geographic limitation confines the use of banked wetland credits for use as mitigation to the Green River and Little Snake River Basin. The ecologic limitation provides for the withdrawal of credits for mitigation of unrelated projects only within the same biotic region and for impacts to the same wetland system and class (Cowardin System). For the purposes of wetland banking, there are three broadly defined biotic regions: Mountain Range; Plains; or High Desert.

4.5 Wetland Banking Summary

Since construction of the stock ponds and reservoirs may create wetlands that may be eligible for the State Wetland Bank, the WWDC may have an interest in obtaining ownership for these wetland banking credits. The credits may be beneficial in terms of mitigation associated with future water development projects. Ownership of the wetland banking credits belongs to the landowner;
consequently, a legal agreement will be required to transfer the ownership of these credits to the District and ultimately the WWDC.

The limitations associated with the wetland banking credits reduce their potential value. Geographically, the wetland credits must be utilized within the region in which the credits were derived. Conversations with Mr. Matt Bilodeau from the COE Wyoming Regulatory Office in Cheyenne, Wyoming indicate that utilization of these credits could be further restricted to the watershed in which the credits were derived. This means that credits generated within the Little Snake River Basin may be limited to mitigation for projects within the Little Snake River Basin. With respect to the ecologic limitation, credits can only be utilized as mitigation if they are associated with a project within the same biotic region.

To date, no wetland banking credits have been withdrawn as mitigation for a construction project within the State of Wyoming. The use of wetland banking credits as mitigation for future projects has not been tested; consequently, the viability of this process is unknown until a project has been identified and successfully passed the scrutiny of the COE/EPA permitting review process.

Finally, it may not be prudent to invest significant resources to facilitate wetland development at each stock pond/reservoir site. The potential for success is relatively low at some sites due to environmental factors such as low precipitation, high evaporation, possibly high sedimentation rates, sandy soils and seepage, topography, and the life expectancy of the impoundment(s). These factors tend to inhibit the formation of self-sustaining wetlands suitable for banking.
V. EVALUATION CRITERIA

5.1 General

An integral part of the planning process associated with this Level II project is the development of evaluation criteria. The criteria identified for evaluation of the proposed stock ponds/reservoir sites are intended to guide the WWDC in the evaluation, conceptual design and funding of future livestock reservoir projects. In addition, these criteria, along with an evaluation matrix, were developed to assist in the selection and priority ranking of the stock pond/reservoir projects associated with this Level II project.

5.2 Discussion of Evaluation Criteria

The list of criteria for evaluating the stock ponds/reservoir sites was developed in conjunction with input received from key members of the project team including Mr. Mike Carnevale (WWDC staff) and Mr. Larry Hicks (District). Primary and secondary criteria were developed and identified below.

<table>
<thead>
<tr>
<th>Primary Evaluation Criteria</th>
<th>Secondary Evaluation Criteria</th>
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<td>Reliable Water Source</td>
<td>Material Suitability/Availability</td>
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<td>Livestock Benefits</td>
<td>Project Beneficiaries</td>
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<td>Public Access</td>
<td>Wildlife/Wetland Benefits</td>
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<td>Project Costs (Construction/O&amp;M)</td>
<td>Wetland Banking Opportunities</td>
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<td>Project Benefit/Cost</td>
<td>Permitting Requirements &amp; Environmental Constraints</td>
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<td>Recreational/T&amp;E and Sensitive Species Benefits</td>
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<td>Potential for Alternative Funding</td>
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A brief discussion of the primary and secondary criteria are presented below.

5.2.1 Primary Evaluation Criteria

The capability of each site to provide for a Reliable Water Source is considered very important. A site that provides a reliable water source is one that would provide a 20-year supply of water for livestock purposes. The annual water yield associated with the watershed upstream of
the dam site is determined and compared to the reservoir yield. The reservoir yield considers the capacity of the reservoir, sediment accumulation and evaporation.

Livestock Benefits are evaluated by comparing the livestock potentially supported by the reservoir service area with the number of livestock supported by the reservoir during the 20-year life of the pond. A value of 4 acres per Animal Unit Month (AUM) is utilized to determine the livestock supported by the reservoir service area. The number of AUMs the reservoir capacity would support is based on consumption of 18 gallons/AUM/day. The reservoir capacity determined after 20 years is utilized in the comparative analysis. This approach accounted for sediment accumulation and the reduction in capacity during the 20-year life of the pond. In addition, the number of acres of rangeland improved by the stock ponds/reservoirs is evaluated. In general, the number of acres of rangeland improved by the stock ponds/reservoirs ranged from 160 acres to over 1,000 acres.

Conversations with the WWDC staff indicated that Public Access has generally been required for new reservoirs and is considered an important criteria for the evaluation of proposed stock ponds/reservoir sites. This is especially true if secondary benefits are generated with respect to recreational fisheries and wildlife. Access to each site was initially evaluated with respect to the location of public roads (county or BLM). Consideration was also given to accessibility to the site from public lands versus crossing private property (thereby requiring an easement).

Project Costs are always considered an important item in water development projects. For this Level II project, the costs associated with construction of a stock pond/reservoir are dependent on the size of the embankment, spillway requirements including need for stabilization measures, access for construction, materials suitability/availability with respect to embankment and spillway construction, legal/administration costs, engineering costs and permitting costs. Estimates of the costs associated with construction are developed and a unit cost per acre-foot of reservoir capacity determined for each site. The relative comparison of construction costs associated with each stock pond/reservoir site is based on a unit cost of $2,000 per acre-foot. Those sites with unit costs less than $2,000 per acre-foot are considered the most favorable while those sites greatly exceeding $2,000 per acre-foot are the least favorable.

Project Benefit/Cost analyses often dictate the economic feasibility of a given project. The benefits associated with each stock pond/reservoir can be categorized as either tangible or intangible benefits. The tangible benefits, which are directly related to the increase in the AUMs afforded by each stock pond/reservoir, can be easily quantified. Intangible benefits associated with potential for wetland banking, recreational fisheries and T&E species and species of special concern, and wildlife/wetland benefits are more difficult to quantify. The approach taken to evaluate the benefits associated with each stock pond/reservoir site initially involves an estimate of the value and number of AUMs supported by the reservoir service area and potential wetland acreage developed by the project. These benefits are then increased by as much as 15% to account for potential improvements.
to water quality, recreational fisheries and T&E species and species of special concern, and wildlife habitat. Project costs are compared to benefits for each site and a benefit/cost ratio is determined. Those sites with benefit/cost ratios greater than 0.7 are considered the most favorable while those sites with benefit/cost ratios less than 0.2 are the least favorable.

The potential for storing water for irrigation was also identified during a discussion with Mr. Larry Hicks. It should be noted, however, that the present operating criteria of the WWDC includes project benefits to 2,000 acres or more of irrigated crop land as a consideration for advancing a project to Level II status. Although insufficient information was collected as part of this study to determine the number of acres which will receive water for irrigation, it is likely that less than 2,000 acres of rangeland will receive the benefit of water for irrigation purposes. Furthermore, while this would create additional tangible benefits associated with each stock pond/reservoir site, it was determined that additional costs will be incurred to construct the facilities necessary to irrigate the adjacent rangeland. Consequently, the costs were determined to offset the benefits and this evaluation criteria was not investigated further.

5.2.2 Secondary Evaluation Criteria

*Embankment Material Suitability/Availability* at a given site may impact the size of the reservoir as well as the costs to construct the embankment and spillway. The parameters that are utilized to evaluate each stock pond/reservoir included foundation suitability, suitability and availability of primary embankment soils, and suitability and availability of secondary embankment soils. Each parameter is rated from very poor to very good and a composite rating was determined for each site.

The number of *Project Beneficiaries* is typically an important factor in all water development projects. The beneficiaries associated with each site are identified for this Level II project. Those sites located on public or state lands with multiple leases receive the most favorable rating while a single beneficiary on private land receives the least favorable rating.

*Wildlife and Wetland Benefits* are identified as an important secondary evaluation criteria. Each site is evaluated for potential development or loss of riparian habitat, potential habitat function and value, and potential for improvements in water quality. Those sites with the most potential for improving these values are considered the most favorable while those sites with limited potential receive the least favorable rating.

The potential for *Wetland Banking Opportunities* is also evaluated at each stock pond/reservoir site. Initially, the potential number of acres created and considered eligible for the wetland bank is estimated. The successful establishment of wetlands at each site is also dependent
on environmental factors such as precipitation, evaporation, sedimentation rates, sandy soils and seepage. Those sites where the environmental factors do not tend to inhibit the formation of self-sustaining wetlands suitable for banking receive a more favorable rating. At these locations, the larger number of potential wetland acres, the more favorable the rating. Where environmental factors tend to inhibit self-sustaining wetlands, a less favorable rating is assigned.

Permitting Requirements/Environmental Constraints associated with each stock pond/reservoir are initially evaluated. It is assumed for this evaluation that individual permit applications would be submitted for each site. Consideration is given to those sites where agricultural exemptions may apply or nationwide or individual permits may be required. In addition, consideration is also given to those sites located on federal lands where completion of an environmental assessment may be required. The most favorable rating is assigned to those stock ponds/reservoir sites which involve the least effort in obtaining the necessary permits.

Recreational/T&E and Sensitive Species Fishery Benefits are also evaluated for each stock pond/reservoir site. Creation of habitat for recreational trout fisheries is based on a minimum depth of 10 feet and a surface area of at least 1 acre. A determination of self-sustaining recreational fisheries versus fisheries where annual stocking requirements are incurred is based on a cursory evaluation of streams where trout populations presently occur. The creation of habitat for candidate T&E species (roundtail chubs, flannel mouth suckers, and blue head suckers) is also evaluated. The most favorable rating is assigned to those sites where the greatest fishery benefits were identified. Sites with minimal benefits to fisheries receive the least favorable rating.

The Potential for Alternative or Supplemental Funding is also included as an evaluation criteria for this Level II project. Funds obtained from alternative sources can potentially increase the number of stock ponds/reservoir sites constructed. This is especially noteworthy in consideration of the Districts’ ability to pay for construction of the stock ponds/reservoir sites. The District has a successful history of obtaining matching funds from alternative sources to construct similar stock ponds/reservoir sites. At those sites where the greatest potential increase in wildlife/wetland benefits or fishery benefits exists, the greatest potential for alternative funding also exists. Those sites where limited wildlife/wetland benefits and fishery benefits have been identified will likely benefit the least from the alternative funding sources.

5.3 Reservoir Evaluation

The primary evaluation criteria tend to serve the primary purpose of the project; i.e., to meet requirements for livestock watering and improvements to rangeland. Secondary evaluation criteria are developed to assess the benefits associated with the potential increase in wildlife habitat, wetland
development, and fisheries. Each criterion is assigned a weighting factor which indicates the importance of the criterion in the evaluation process. The weighting factors range from a value of 1 (less important) to a value of 3 (most important). All primary evaluation criteria are assigned a weighting factor of 3 which is consistent with the primary purpose of this Level II project. A weighting factor of 2 is assigned to embankment material suitability/availability, project beneficiaries, wildlife/wetland benefits, and potential for alternative or supplemental funding. The weighting factor of 1 is assigned to the remaining criteria. Finally, the capability of a given stock pond/reservoir site with respect to each evaluation criterion is determined on a scale which ranged from 1 (least favorable) to 5 (most favorable). Figure 3 presents the evaluation matrix developed to compare the reservoir sites identified during the completion of this project.
Figure 3. Reservoir Evaluation Matrix.

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<td>8. Wildlife/Wetland Benefits</td>
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<td>5 - Most Favorable</td>
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VI. REVIEW OF OPERATING CRITERIA

6.1 General

This chapter presents the results of a cursory review of the operating criteria of the water development program. Special attention is focused on areas where changes should be made to better clarify the eligibility of projects such as this Level II project sponsored by the Little Snake River Conservation District (LSRCD).

6.2 Review Comments

The Level II project sponsored by the District falls into the New Development Program since the project develops presently unused and/or unappropriated water of Wyoming. The following comments pertain to those sections of the operating criteria that specifically relate to the project proposed by the LSRCD or similar projects in the future.

Section I.A.1

Sponsored projects require an approved assessment district which must be willing and capable of financially supporting a portion of the project development costs and all operation and maintenance costs. A determination of whether the LSRCD is capable of financially supporting a portion of the project development costs and all operation and maintenance costs must be made. Consideration should include: (a) the District’s ability to enter into long-term agreements/mortgages, and (b) maintenance responsibility by the District for the design life of each structure.

Section I.B.3

The last paragraph in this section is devoted to a discussion of developing the water resources of the State of Wyoming. This paragraph states “the criteria for scheduling program resources is based on the general philosophy that the efficient consumptive beneficial use of Wyoming’s water will insure its preservation for Wyoming’s purposes”. This statement seems to support the project sponsored by the LSRCD.

Section II

On page 6, a reference is made to W.S. 41-2-12(b) which states “the commission shall: (i) Emphasize multipurpose water projects for maximum benefits and cost allocation....”. The project sponsored by the LSRCD can be considered a multipurpose water project.

On page 7, a reference to W.S. 41-2-121 discusses recommendations for water development proposals provided by the water development commission to the
legislature. This section states "The commissions recommendation shall: (A) Emphasize projects developing unappropriated water; (B) Give preference wherever possible to projects developing new storage capacity...." The LSRCD project applies to both of these items.

Section III.A.1 This section states "These projects can be constructed if the sponsor has the ability and willingness to pay a portion of the development costs and all of the operation, maintenance and replacement costs and is a public entity that has the legal ability to generate revenues to repay project loans and can legally receive grant funds." It does not appear that the LSRCD is a public entity that has the legal ability to generate revenue to repay project loans. This issue needs to be resolved. Furthermore, if the LSRCD can obtain grants from other funding agencies, then this could be considered as an ability and willingness to pay for the development costs. The ability and willingness to be legally bound to pay for the operation, maintenance and replacement costs for the life of the project must be further investigated.

Section III On page 10 and 11, a discussion of the priorities relative to the types of water projects the program should pursue is presented. The first two priorities involve multipurpose projects and storage projects. The LSRCD project applies to both priorities although it is recognized that these priorities pertain to much larger water storage projects. Consequently, it may be prudent to better define the size of multipurpose and/or storage projects.

Section III On page 13, clarification to the list of priorities relative to the types of water projects the program should pursue is provided. Item 4 of this section states "While the feasibility of providing environmental improvements should be considered on all program projects, the program does not have the resources to pursue projects which serve the sole purpose of environmental enhancement. There are other state agencies which have the authority and funding to pursue these projects". With respect to the LSRCD project, some of the stock ponds/reservoir sites could be construed as primarily wetland ponds or ponds that serve to enhance wildlife, wetlands and fisheries. Funding for these projects may be questionable. It should be noted, however, that the existing operating criteria allow the development of water projects whose primary purpose is to enhance recreation (page 12, item 7).

Section III.B.1.e This section pertains to a public entity that can incur debt, generate revenues to repay a state loan and legally receive grant funds. Similar to previous comments, this issue with respect to the LSRCD or similar Districts needs to be resolved. A legal definition of a "public entity that can incur debt" is necessary.

Section III On page 15, a discussion related to the criteria associated with acceptance of the project application for incorporation into the program is presented. Item b of this discussion asks the question "Is the Water Development Program the most
appropriate source of funds for project study and construction?” The answer to
this question with respect to the LSRCD project or similar projects may depend
on the nature of the project; i.e., a multipurpose project may be considered
whereas an environmental project may not be considered.

Section III

On page 16, a discussion of the considerations for advancing a Level I study to
Level II is presented. These considerations include “Will the proposed projects
serve twenty (20) or more municipal/domestic water taps or 2,000 or more acres
of irrigated crop land?” and “Will the Water Development Program’s investment
be less than $10,000 per active municipal/domestic water tap or $500 per
irrigated crop land acre?” Both of these considerations will require modification
to reflect the type of project sponsored by the LSRCD. Considerations for the
number or acres of rangeland improved should be provided along with a
maximum investment per acre of rangeland.

Section III

On page 20, examples of issues that should be considered in the development of
Level III recommendations are presented. In particular, these issues include “Is
the project a good investment for the State of Wyoming considering primary and
secondary project benefits as well as the indirect benefits of putting Wyoming’s
water to work for the benefits of its citizens?” and “Is the project affordable given
the existing status of the water development account and prior commitments to
the account?” The LSRCD project or similar projects does provide the
referenced primary and secondary project benefits as well as indirect benefits.
The determination of whether the project is a good investment appears to be
discretionary. Also, the determination of project affordability also appears to be
discretionary.

6.3 Additional Issues and Considerations

Based on the review of the existing operating criteria as well as the work conducted to date
on this Level II project, the following comments are provided.

1. In view of the information provided by Inberg-Miller Engineers, it is recommended
that a licensed engineer registered in the State of Wyoming be directly responsible
for the design and construction of all reservoirs completed with state funds.
Accountability for the design and construction of the project should rest with the
professional engineer.

2. Given that the LSRCD is interested in maximizing the reservoir sites, a determination
should be made regarding the funding of a reservoir which may serve livestock water
purposes but the majority of the storage is for environmental enhancement. This
determination may be made by a simple investigation of benefit/cost ratios related
to a reservoir which simply meets the needs for livestock watering versus a reservoir which provides for both livestock water and environmental enhancement.

3. A potential exists to obtain wetland banking credits associated with the construction of this project. The WWDC should determine whether the State is interested in obtaining the wetland banking credits since state funds may be utilized to create these credits. Furthermore, if the state desires to obtain the credits, an agreement should be formulated between the landowner, LSRCD and WWDC that would allow the transfer of the credits to the state. The amount of each credit that is transferred to the State should be determined.

4. The LSRCD may obtain funding from other sources to offset the loans associated with the any Level III appropriation for the proposed project. It may be prudent to ensure that a commitment for this funding is obtained before the project proceeds to construction. Furthermore, if the LSRCD has a limited ability to incur debt, it should be noted that funding will be required for annual operation and maintenance of the stock ponds/reservoirs as well as maintenance of potential wetlands eligible for the State Wetland Bank. The LSRCD should be willing, capable and legally committed to pay for these annual operation and maintenance costs. A trust account, established for maintenance of these facilities and assigned to the WWDC, may be necessary to ensure a commitment for payment of these costs.

5. It may be appropriate for the WWDC to establish criteria or rules/regulations that specifically indicate the size of the reservoirs that are eligible for the program. Conceivably, a stock pond that is 1 to 2 acre-feet may be considered eligible under the existing criteria. Furthermore, the WWDC may wish to consider the development of operation and maintenance/annual inspection guidelines for these facilities. Guidelines for the assurance of public access may be warranted (i.e., documentation of the required easements from landowners). Finally, refinement of the definition of public benefits associated with these projects should be considered.
At the request of the WWDC, a legal review of the laws pertaining to Conservation Districts was completed. Specific attention was devoted to the qualifications of Conservations Districts as project sponsors. This issue was investigated by Ms. Kate Fox of Davis & Cannon. A summary of her work is provided below.

The legal nature of a conservation district gives it dubious qualifications as a project sponsor. Conservation districts are authorized pursuant to Wyo. Stat. §§11-16-101 et seq. The laws impose two severe limitations on their ability to make long-term financial commitments. First, Wyo. Stat. § 11-16-123(b) provides that no contract entered into by a district is valid if it commits to payment of money in excess of the district’s assets at the time the contract is made. Second, conservation districts get their income by taxing their members, and the imposition of the tax can be defeated by general election of the members (Wyo. Stat. § 11-16-134(c)). There is no assurance the LSRCD would have the continued financial ability to maintain this project, much less repay a loan in any amount.
Figure 3. Reservoir Evaluation Matrix.

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### RANKING

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