EXECUTIVE SUMMARY

Middle Piney Reservoir
Level II Study

Prepared for:
Wyoming Water Development Commission

Prepared by:
States West Water Resources Corporation
Cheyenne, Wyoming

In association with:
Miller Geotechnical Consultants, Fort Collins, Colorado
Rio Verde Engineering, Pinedale, Wyoming
Short Elliot Hendrickson, Cheyenne, Wyoming
Dave Eckles, Archaeologist, Laramie, Wyoming
Watts and Associates, Laramie, Wyoming

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Please note that this executive summary is intended to complement the final report. More information and detail can be found in the final report. All conceptual design drawings are also located in the final report.
INTRODUCTION
Construction of Middle Piney Dam was completed in 1940. From construction until the early 1990’s, the dam served private irrigators. However, the irrigators were located near the lower end of the Middle Piney Creek drainage. The users were not successful in transporting the storage water to their points of use. Consequently, the reservoir was of no value to the users.

As such, in 1993, the water users started to give their shares to the United States Forest Service (USFS). USFS obtained full ownership of the facility in 1998. Due to the dam being classified as a high hazard structure because of its potential for loss of life or property in the event of failure and noted seepage and outlet works problems, USFS maintains the control gate in the open position and does not use the historic storage. USFS is considering breaching the embankment to remove any liability.

Water shortages during the recent drought resulted in downstream water users looking for additional water supplies and initiated consultation with USFS about reacquiring Middle Piney Reservoir. The chief concern among all parties was the safety of the dam and the need to rehabilitate the structure to meet the current guidelines of the Wyoming State Engineer’s Office (SEO) Dam Safety Division.

To accomplish this task, Chad Espenscheid, a local irrigator, submitted a request on behalf of the other Middle Piney irrigators to the Wyoming Water Development Commission (WWDC) for a Level II study. In June 2006, WWDC executed a contract with States West Water Resources Corporation to complete this project.

This report investigates the feasibility of reconstructing and enlarging Middle Piney Reservoir in order to maximize water storage options and alleviate water shortages within the Middle Piney Creek basin.

EXISTING STRUCTURE RECONNAISSANCE
States West Water Resources (States West) and Miller Geotechnical Consultants (MGC) conducted site investigations to determine the condition of the existing facility. Our team investigated the outlet works, embankment, spillway, and access road. We also determined how much water the reservoir currently holds and investigated how much water seeps through the dam. Rio Verde Engineering completed a topographical survey of the existing structure. Following are the areas of immediate concern for dam safety.

Area Capacity
Rio Verde Engineering completed a survey of the dam and reservoir area in September 2006. This survey showed that the crest elevation of the spillway was located at 8,836 feet. The elevation of the spillway crest should establish the historic elevation of the normal high water line (NHWL).

Figure 1 shows the area-capacity curves for Middle Piney Reservoir. According to the capacity curve, Middle Piney Reservoir would have an estimated total storage of approximately 3,350 acre-feet at elevation 8,836 feet, which is below its permitted capacity of 4,201 acre-feet. Please note that these curves are an estimate because of limited survey data. The area-capacity
relationship of the inlet area of the reservoir had to be estimated from U.S. Geological Survey (USGS) topographical maps, as the survey did not include this entire area. In order to file a construction permit with the SEO Dam Safety Division, an accurate area-capacity curve will be required.

Figure 1
Middle Piney Reservoir Area-Capacity Curve (Above Natural Lake Level)

The NHWL would have to be increased by approximately 4 feet to elevation 8,840 feet to develop the permitted capacity of 4,201 acre-feet. Alternatively, the outlet works would have to be lowered 5 feet to elevation 8,810 feet to develop the permitted capacity of 4,201 acre-feet. However, the dam survey shows that the discharge channel and creek elevations would not allow the outlet works to be lowered.

Outlet Works
The outlet works piping at Middle Piney Dam consists of a 42-inch diameter corrugated metal pipe. There is an intake structure in the reservoir that leads to a gate structure where a sluice gate is located that can be used to control the outlet works.

The concrete in the intake structure shows deterioration and cracking problems. These cracking problems probably result from differential settlement beneath the concrete structure. This intake structure is also prone to clogging from debris, which could cause the outlet works pipe to plug.

The gate structure has also seriously deteriorated. The gate structure consists of a CMP access that extends to a concrete vault where a 42-inch sluice gate is located. There is significant cracking within this concrete vault. The cracking in this vault is a structural concern that would...
necessitate the replacement of this structure. The cracking is probably a result of differential settlement underneath the vault. The sluice gate and operator are also in poor condition and need to be replaced.

The main outlet works piping consists of a 42-inch diameter CMP. This pipe has deteriorated significantly. The pipe has rusted significantly with the expectation that the pipe will continue to deteriorate. There has also been settlement that has caused the pipe to warp and crack in places. This warping and cracking could cause water to infiltrate the dam foundation, which could eventually cause a piping failure in the dam.

**Embankment**

The existing dam embankment is situated along the upstream margin of a massive landslide complex that comprises the right abutment of the dam. The landslide is an ancient feature that originated on the mountain slope southeast of the current dam site and failed towards the north across the valley bottom. The slide mass formed a natural lake. The original creek path was displaced to the north, overflowing the toe of the slide complex adjacent to the north slope of the valley. A 28-foot high, approximately 100-foot long embankment dam was constructed across the creek near the upstream margin of the landslide complex, taking advantage of partial valley fill created by the landslide.

**Spillway and Access Road**

The spillway at Middle Piney Dam consists of a 20-foot wide, 4-foot deep trapezoidal shaped unlined channel. The spillway also serves as the access road to the dam.

The spillway is in relatively good condition; there is no erosion or sloughing present within the channel. However, our team had concerns in that the spillway also serves as the access road. In this configuration, access to the dam is not possible should any flood event occur when the reservoir is full. As currently configured, the spillway has a capacity of approximately 600 cfs.

The access road to the dam is in poor condition. Floods in July 2008 caused a section of the road located approximately one-quarter of a mile from the dam to fail. Currently, USFS is not allowing vehicular access to the dam.

**Seepage Analysis**

Middle Piney Reservoir has had a history of seepage issues. States West completed a seepage analysis study that lasted from November 2007 to July 2008 to help quantify the seepage through and around Middle Piney Dam. This study consisted of two parts. First, the level of the reservoir was measured approximately every other month through the winter to determine how much the reservoir drops during this time due to seepage. Second, streamflow was measured at four monitoring sites approximately every other month throughout the length of the study to determine how much the flow varied within Middle Piney Creek and to help ascertain whether that flow came from Middle Piney Reservoir.
Reservoir Measurement
The reservoir level was measured approximately every other month throughout the winter to see how much the reservoir drops during the winter. Reports from local citizens suggested that the reservoir dropped as much as 20 feet during the winter due to seepage.

The water level of Middle Piney Reservoir did not drop appreciably during the winter. From November 2007 to March 2008, the water level dropped by a total of approximately 10 inches. The drop in water level is consistent with winter evaporation rates in the area. We did not observe any water flowing into Middle Piney Reservoir during this time. Therefore, we have concluded that most of the drop in the water level is due to evaporation and not seepage.

Stream Level Measurement
Streamflow was measured at four monitoring sites approximately every other month throughout the length of the study to determine how much the flow varied within Middle Piney Creek and to help ascertain whether that flow came from Middle Piney Reservoir. From November 2007 to March 2008, there was no water flowing immediately downstream of Middle Piney Dam. However, water did appear in Middle Piney Creek further downstream during these months. We have concluded that the source of water for the downstream sites is from springs located along the banks of Middle Piney Creek. We do not believe that these stations are being fed by water from Middle Piney Reservoir, as the water level in Middle Piney Reservoir did not drop by an equal amount during this time.

During spring runoff, the water level in Middle Piney Reservoir rose to 8,828.66 feet (approximately 13 feet above the invert of the outlet works pipe). During this time, several seeps opened up immediately downstream of the dam. We estimate that these seeps discharged between 5 and 10 cfs total with the largest seep discharging approximately 1 cfs by itself. Since most of the seeps opened up only after the water level in Middle Piney Reservoir increased, we have concluded that most of the seepage pathways are relatively shallow.

Reservoir Yield Analysis
The total amount of water flowing into Middle Piney Reservoir and, therefore, the amount of water available for storage is a product of the amount of runoff that is produced by the Middle Piney Reservoir drainage basin. Runoff amounts are usually calculated using stream gaging stations located within the basin. The average runoff measured by these gaging stations can then be used to determine how much water can be stored in a given reservoir in the average year.

States West conducted a brief hydrological study (in conjunction with the seepage analysis) from November 2007 to July 2008. We monitored the inflow and outflow rates for the reservoir in order to determine approximately how much water is available for storage in the average water year.

The storable flow for the average water year is estimated to be 2,971 acre-feet per year. We assume that the entire contents of the reservoir would be used on a yearly basis. There would be no carryover storage. Please note that this estimation is based on 1 year of gaging data.
**Middle Piney Hazard Classification**
The hazard classification of a dam and reservoir is determined by the potential for loss of life and significant damage to property caused by dam failure. The Wyoming State Engineer’s Office requires that dams and reservoirs whose failure could cause loss of life or significant property damage be designed for the PMF. To determine the classification, a dam break analysis was performed.

If Middle Piney Dam failed, there would be a potential for loss of life and significant damage to all properties located within the Middle Piney Creek basin before the confluence with Indian Creek. Sacajawea Campground would particularly be at risk as that area would be inundated by approximately 10 feet of water. Areas downstream from Sacajawea Campground to the confluence with Indian Creek would be inundated by approximately 12 feet of water. Consequently, Middle Piney Dam is classified as a high hazard dam due to the potential for loss of life and significant damage to property and must be designed to pass the PMF.

**Middle Piney Flood Analysis**
Table 1 details the maximum flood flowrate into the reservoir and the total volume for each flood event. As currently configured, the spillway can only pass flows up to about 600 cfs. The spillway needs to be enlarged in order to be able to manage the PMF.

<table>
<thead>
<tr>
<th>Flood Event</th>
<th>Duration [Hours]</th>
<th>Maximum Flowrate [cfs]</th>
<th>Total Volume [ac-ft]</th>
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<td>184</td>
</tr>
</tbody>
</table>

**Design Criteria**
Rehabilitation alternatives should meet certain design parameters. These design parameters were established as follows:

1. The dam should be an earth embankment dam. Two different types of dams were considered for the Middle Piney Dam: a roller compacted concrete (RCC) dam and an earth embankment dam. The RCC section has the advantage of incorporating the spillway into the dam. However, an RCC dam section requires a very high strength foundation with minimal differential settlement potential. The Middle Piney Dam site has neither of these qualities. Therefore, an RCC dam section would not be feasible for this site. An earthen dam is the best alternative.

2. The new outlet works should have the capacity to pass required irrigation flows under low head conditions (2 feet or less) and all floods up to the 100-year level without use of the emergency spillway. The intake structure should be designed to prevent debris from plugging the pipe. The NHWL elevation of the reservoir should be maintained automatically.
3. The emergency spillway should have the capacity to pass the PMF flow of 24,446 cfs without overtopping the dam crest. The emergency spillway should also discharge flow away from the dam so that the structural integrity of the dam is not threatened.

4. The operating levels for the dam should be set to ensure that the 100-year flood can be contained within the reservoir without using the emergency spillway and the PMF can pass through the emergency spillway without overtopping the dam.

**Preliminary Design**
The existing outlet works is in poor condition and must be replaced. Replacing the outlet works would require that the embankment be entirely excavated. Therefore, our team feels that the best rehabilitation option for Middle Piney Dam is to rehabilitate the entire structure completely.

Three alternatives were analyzed for this study:

1. **Alternative 1 – Rehabilitate dam at current location with current capacity**

   Reconstruct the existing dam, outlet works, and emergency spillway at its current location. The reservoir would have a storage capacity of 3,350 acre-feet. This alternative would replace the existing outlet works, which would necessitate reconstructing the existing dam. The emergency spillway would also be widened.

2. **Alternative 2 – Construct a new dam on a downstream alignment with current capacity**

   Construct a new dam on a downstream alignment located approximately 200 feet downstream of the existing alignment. The reservoir would have a storage capacity of 3,350 acre-feet. This alternative would use the existing upstream embankment dam as a temporary upstream cofferdam. A new dam and outlet works could be constructed downstream from the existing dam on a suitable alignment. The existing emergency spillway would be widened and lengthened. After construction of the new dam is complete, the existing structure would be removed and replaced with fill.

3. **Alternative 3 – Rehabilitate dam at current location with permitted capacity**

   Reconstruct the existing dam, outlet works, and emergency spillway at its current location. The reservoir would have a storage capacity of 4,201 acre-feet. This alternative would replace the existing outlet works, which would necessitate reconstructing the existing dam. The emergency spillway would also be widened.

**Environmental Investigation**
SEH completed an environmental investigation report. The environmental investigation report assessed and identified potential impacts that this project could have on the following biological resources:
• Proposed and endangered species
• Big game seasonal ranges
• Raptor nesting locations and habitat
• Wildlife and fisheries resources
• Wetlands and rare plant species

The project occurs within the potential range of the whooping crane, gray wolf, and Canada lynx. However, the environmental investigation report indicates that this project will have no effect on any of these ranges. The environmental investigation report also mentions that this project would not affect critical big game habitat, raptor nesting sites, wildlife resources, or fishery resources.

The environmental investigation report found that there would be minimal environmental impacts if the dam were rehabilitated to its historic storage level. Formal wetland delineation may be required depending on whether construction activity impacts the waters of the United States; however, it is not anticipated that the impacts would exceed the mitigation threshold of 0.1 acre if wetlands were determined to be present. The wetlands that have developed in the historic storage pool would not have to be mitigated. The only wetland impacts that could occur are insignificant areas below the existing embankment in the channel.

The report also found that there could be considerable environmental impacts if the dam were to be enlarged. A formal delineation of the wetlands located downstream and upstream of the dam would need to be completed. The wetland impact of enlargement on the upstream end of the reservoir would be significant. A 5-foot raise in the reservoir level would impact approximately 1.5 acres of wetlands.

Wetland mitigation areas close to the project site would be difficult to find in the area. Any disturbed wetlands would have to be mitigated at a minimum two to one (2:1) ratio. USACE would determine the actual ratio.

ARCHAEOLOGICAL INVESTIGATION
The Office of the Wyoming State Archaeologist completed a class I cultural survey. The archeological survey indicated that there would not be any prehistoric or historic sites expected within the immediate area of the dam. Middle Piney Dam is over 50 years old and is itself regarded as a historic site. As part of the rehabilitation, the dam would have to be recorded with measurements, photographs, and descriptions of its current condition.

PERMITTING
A significant number of permits could be required for Middle Piney Reservoir. The type and number of permits that will be required will be dependant upon whether a rehabilitation or enlargement project will be pursued. Permits issued by the U.S. Forest Service, U.S. Army Corps of Engineers, and Wyoming State Engineer’s Office were investigated.

United States Forest Service
The Middle Piney Reservoir rehabilitation project is located within the Bridger-Teton National Forest and USFS will require a Special Use Permit Application and authorization from the local

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water users should they pursue the rehabilitation of the dam. Transfer in ownership of the dam from USFS to the water users could be conditioned whereby the rehabilitation of the dam will only allow for safety improvements and no expansion of the existing facility.

Environmental impacts from dam rehabilitation appear to be minor and limited to the existing dam abutments and downstream toe. However, USFS will require an Environmental Assessment to accompany the Special Use Application that will address the anticipated impacts from rehabilitation. Upon transfer of the facility to the local water users and acquisition of the Special Use Permit for the facility, annual lease payments may be required by USFS.

United States Army Corps of Engineers
It does not appear that significant wetlands would be impacted by rehabilitating the existing structure. It is assumed that the Army Corps of Engineers would issue a Nationwide Permit for the structure improvements. This permit is simply a letter from the Wyoming office of the Corps of Engineers authorizing the proposed work on the facility.

An enlargement of the reservoir would impact significant wetlands and would require an individual Section 404 Permit. This permitting process would involve much more rigorous Environmental Assessment or Environmental Impact analyses.

Wyoming State Engineer’s Office
Since the Middle Piney Reservoir is a high hazard dam, any proposed improvements will require a Permit to Construct from the State Engineer’s Office. The SEO Dam Safety Division will also review and approve the plans. A surveyed area-capacity curve will also have to be submitted at this time. In addition, a revised storage filing will have to be submitted if any storage is going to be abandoned.

Recommendations
States West recommends that the Middle Piney Creek irrigators submit an application to the Wyoming Water Development Commission to request Level III funding for Alternative 1. This alternative would rehabilitate the current dam at the current location with the current capacity of 3,350 acre-feet. Conceptual drawings for this alternative can be found at the end of this executive summary. Descriptions of each individual dam feature can be found in the final report. This recommendation is based on several factors:

1. Cost
   Alternative 1 is the most economical alternative. Alternative 1 is approximately $240,000 less expensive than Alternative 2 and $450,000 less expensive than Alternative 3. A detailed cost estimate for Alternative 1 can be found in Table 2.
Table 2
Alternative 1 (Rehabilitate Dam at Current Location with Current Capacity) Cost Estimate

<table>
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<th>Quantity</th>
<th>Unit Cost</th>
<th>Total Cost</th>
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2. Ownership
The United States Forest Service is opposed to an enlargement beyond the historic storage level. USFS may not transfer ownership of the dam to the irrigators if Alternative 3 is pursued.

3. Permitting
We believe that the Army Corps of Engineers would issue a Nationwide Permit for Alternative 1 and Alternative 2 because these alternatives would utilize the historic storage of Middle Piney Reservoir. However, Alternative 3 would increase the historic storage and wetland impacts. We believe that the Army Corps of Engineers would require a Section 404
Permit for this alternative. This permit will be much more difficult, and perhaps impossible, to obtain because of the wetland impacts associated with Alternative 3. These impacts may be immitigable as no wetland mitigation areas located near the reservoir.

4. Yield
We do not believe that there is enough yield in the Middle Piney Creek basin to justify an enlargement. We calculated that the average annual yield would be approximately 2,971 acre-feet. We do not believe that the additional storage in Alternative 3 would be utilized except in the wettest of years when water supply is not an issue.

Additional recommendations related to advancing Alternative 1 to the construction phase can be found in the final report.