



# DAM CONDITION STUDY

FOR PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Davis Engineering Service, Inc.

January 15, 2020



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Mr. Larry Lynch  
Mr. Allen Roth  
Pagosa Lakes Property Owners Association  
230 Port Avenue  
Pagosa Springs, Colorado 81147

Dear Mr. Lynch & Mr. Roth:

Davis Engineering Service, Inc. (DES) is pleased to provide this Dam Condition Study to Pagosa Lakes Property Owners Association (PLPOA) for Lake Forest Dam, Hatcher Dam, Linn & Clark Dam and Town Center Dam. Within this study we have summarized our review of Dam Inspection Reports, historical documentation, and current dam appurtenance conditions. From this review, part from the Rules and Regulation for Dam Safety and Construction (Rules) requirements of dam owners, and part from past experience, we estimated costs relating to annual maintenance and lengthier frequency items. Finally, a cost estimate is provided for complete replacement of each dam's outlet works. The replacement cost estimates reflect a worst-case scenario, being a partial dam breach with outlet works replacement. The replacement cost estimates do not include outlet modifications required due to hazard reclassification or future Rule changes.

We estimated the remaining design life of each dam's respective outlet components and appurtenances, as these items deteriorate with each passing year. As a dam owner proper maintenance and monitoring can lengthen service life and provide reasonable repair/rehabilitation planning.

PLPOA's dams have varying rates of seepage at downstream areas from year-to-year. Downstream drain outfalls for Lake Forest Dam and Town Center have not been located to date where this has been continually noted within Dam Inspection Reports. The degree of repairs for outfall drain systems can vary in estimating costs along with the level of urgency to have working drain system. We did not include a cost estimate to repair, or make functional, the drain outfall systems for each dam.

Should you have any questions please contact us below or we can schedule a time to review this more in detail.

Sincerely,



Clifton Lee  
Project Engineer  
970-264-5055 ext. 105



Michael Davis  
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## LAKE FOREST DAM

DAMID: 780110

Lake Forest Dam is PLPOA's smallest in size (height and storage) and has a Low Hazard Classification. Lake Forest Dam is an earthen embankment dam and does not have a traditional emergency overflow spillway. At the maximum section of the dam is a concrete drop inlet structure. This structure has an overflow weir configured at the top, and at the bottom of the structure is a 24-inch diameter ductile iron smooth pipe to serve as a low-level intake. Inside the structure is a sluice gate mounted on the inside wall for control of the water level. The concrete drop inlet structure then discharges into a 72-inch diameter aluminum corrugated pipe that passes through the dam embankment structure.

In reviewing the historical Dam Inspection Reports for Lake Forest Dam, repeated notes were indicated about monitoring the seepage at the downstream toe. Over the years, various rates of seepage have been documented where dam inspectors recommended that seepage rates vs. reservoir storage levels be recorded for monitoring which has not been performed on a planned periodic schedule.

### 1974

Year Constructed

- Dam Height of 22.5 feet
- Storage of 465 acre-feet
- Low Hazard Classification
- 46 Years Old

### 1988

Last Major Repair

- Leak at the outlet structure to 72 inch diameter culvert
- Partial breach of the dam was performed for repairs
- Installed a grout ring to stop leakage

### 2001

Last Outlet Inspection

- 72 inch diameter aluminum corrugated pipe
- 20 inch Steel Sluice Gate
- Ductile Iron Pipe for low-level water
- No Emergency Overflow Spillway

PLPOA is to consider the following:

- Operating service life of aluminum corrugated pipe is 75-100 years when installed in an appropriate soil/water environment per Contech (a pipe manufacturer)
- Operating service life of cast iron sluice gates is 40-50 years in a non-corrosive environment with frequent exercise in discussing with a gate manufacturer
- Operating service life of ductile iron pipe is estimated to be 105 years by the American Water Works Association
- Operating service life of concrete can vary and is based on the concrete materials used in the mix, reinforcing steel cover and local corrosive elements

*Note: The service life estimates above reflect timely maintenance, proper installation and suitable conditions.*

To date, Lake Forest dam is 46 years old (2020-1974). When considering the expected service life of the dam structure components, nearly 46% of the operating service life has been reached for the outlet pipe, 44% for the ductile iron pipe and 92% for the cast-iron sluice gate. The cast-iron sluice gate is nearing the end of its service life and PLPOA is to expect issues (e.g. leaks or onerous operation) in the near future. For the concrete intake structure, the remaining service life is unknown, and it should be monitored and repaired as the concrete condition deteriorates.

### **Lake Forest Dam Probable Costs**

We have estimated the present value probable costs for annual maintenance items, engineering service items and complete outlet works replacement which is explained below.

#### ***A. Annual Maintenance Items***

As owner of Lake Forest Dam, PLPOA is to perform annual maintenance items such as rodent control, weed control/management, maintaining gage markers, clearing of trees and brush, replacement/installing riprap, exercising of the outlet sluice gate, seepage vs. reservoir level monitoring, and updating the emergency action plan.

#### ***B. Lengthier Frequency Items***

**Hazard Classification** - Development below Lake Forest Dam continues to change from year-to-year. Currently, Lake Forest Dam is classified in having a low hazard potential. PLPOA is to plan for costs associated with updating and maintaining a proper Hazard Potential Classification with the likelihood of Lake Forest Dam becoming a Significant Hazard (possibly High Hazard) as development continues. PLPOA is to consider engineering costs to perform a Hazard Classification Report every 10 years.

**Inundation Mapping** – For a Low Hazard Classification PLPOA is required to have an inundation map prepared and maintained for Lake Forest Dam. Should the hazard classification change in the future PLPOA is to consider development of a flood inundation map to support an emergency action plan.

**Instrumentation Plan** – Should the hazard classification change for Lake Forest Dam to High Hazard, PLPOA will need to install and maintain survey monuments and piezometers. We include potential future costs to implement and maintain an Instrumentation Plan.

**Outlet Inspection** – We include costs for PLPOA to perform a Type B outlet inspection every 10 years. This inspection is based on using a remote camera system for video inspection.

**Head Gate Replacement** – We include costs for PLPOA to replace the head gate once during a 100-year period. The estimated date of head gate replacement is 2024.

**C. Outlet Works Replacement/Rehabilitation Items**

As previously discussed, approximately 44-46% of the operating service life has passed for the Lake Forest Dam outlet pipes and 92% for the sluice gate. At this time, we predict a worst-case scenario cost estimate for PLPOA to consider for budgeting:

**Outlet Works Replacement** – Replacement of the aluminum corrugated outlet pipe, concrete intake structure, and sluice gate. This approach would require partial breach of the dam structure, removal of the roadway surface above the outlet structure and controls. It is important PLPOA plan for this work with PAWSD (stored water user) and Archuleta County (Lake Forest Circle roadway owner) as impacts would be abrupt. Replacement of the outlet structure and controls would restart the operating service life for the replaced structures. Based on the year of Lake Forest Dam being placed into service we estimate this work to take place in 2074.

Note: Service maintenance of the aluminum corrugated outlet pipe, concrete intake structure, and sluice gate may be an option PLPOA implements with intermittent emptying of Lake Forest. Typical maintenance work would include sealing of concrete, filling of concrete cracks, patching of spalled concrete, cured-in-place pipe lining for the 72-inch diameter outlet culvert, replacement of the sluice gate. We have not included estimates to perform the described service maintenance items as these may not occur at the same time, depend on rate of material deterioration and coordination to empty Lake Forest. We expect service maintenance costs be less than the worst-case scenario discussed above.

We have estimated potential costs for items A, B, and C:

<p><b>Maintenance Items (Annual Costs)</b></p>	<ul style="list-style-type: none"> <li>▪ \$2,520/year for rodent control, removal of weeds, brush and trees, maintaining gage markers, maintaining riprap, operating outlet works, monitoring and documenting seepage vs. reservoir levels, and maintaining the emergency action plan</li> </ul>
<p><b>Lengthier Frequency Items (Varying)</b></p>	<ul style="list-style-type: none"> <li>▪ \$1,150 for survey of dam monuments (every 5 years)</li> <li>▪ \$6,750 for Hazard Class. Report (every 10 years)</li> <li>▪ \$7,500 for Hydrology Report (every 10 years)</li> <li>▪ \$3,360 for Type B Outlet Inspection (every 10 years)</li> <li>▪ \$75,174 for Head Gate Replacement (every 50 years)</li> </ul>
<p><b>Major Dam Outlet Works Replacement 2074</b></p>	<ul style="list-style-type: none"> <li>▪ \$606,564 for Lake Forest Dam Outlet Replacement</li> <li>▪ Based on a 100-year operating service life the expected year for the outlet works replacement is 2074</li> </ul>



## HATCHER DAM

DAMID: 780102

Hatcher Dam is PLPOA’s largest in size (height and storage) and has a High Hazard Classification. Hatcher Dam is an earthen embankment dam with an emergency overflow spillway. At the maximum section of the dam is a steel slide gate at the intake control structure. The intake control structure then continues through the dam embankment structure by a series of 18-inch diameter reinforced concrete pipes to the outlet headwall.

In reviewing the historical Dam Inspection Reports for Hatcher Dam, repeated notes were indicated about monitoring the seepage at the downstream toe. Over the years varying amounts of seepage have been documented with dam inspectors recommending that seepage rates vs. reservoir storage levels be recorded. Hatcher Dam has had high enough seepage rates to warrant review by an Engineer. In a 1971 dam inspection report a seepage rate was noted as being 0.05 cfs. Repeated high seepage then led to the design and construction of a v-notch weir to quantify and record seepage.

**1965**

Year Constructed

- Dam Height of 46 feet
- Storage of 1,735 acre-feet
- High Hazard Classification
- 55 Years Old

**0**

No Major Repairs

- Historical seepage at downstream toe
- Known to have beaver dams and quick vegetation growth

**2017**

Last Outlet Inspection

- 18 inch diameter reinforced con. pipe
- 18 inch diameter steel slide gate with lift
- Emergency Overflow spillway

PLPOA is to consider the following:

- Operating service life of reinforced concrete pipe is 70-100 years according to the American Concrete Pipe Association
- Operating service life of the steel slide gate is 40-50 years in a non-corrosive environment with frequent exercise in discussing with a gate manufacturer
- Operating service life of concrete can vary and is based on the concrete materials used in the mix, reinforcing steel cover and local corrosive elements

*Note: The service life estimates above reflect timely maintenance, proper installation and suitable conditions.*

To date, Hatcher Dam is 55 years old (2020-1965). When considering the expected service life of the dam structure components, nearly 55% of the operating service life has been reached for the reinforced concrete outlet pipe and 105% for the steel slide gate. The steel slide gate is at the end of its service life and PLPOA is to expect issues (e.g. leaks or onerous operation) in the near future.

### **Hatcher Dam Probable Costs**

We have estimated the present value probable costs for annual maintenance items, engineering service items and complete outlet works replacement which is explained below.

#### ***D. Annual Maintenance Items***

As owner of the Hatcher Dam, PLPOA is to perform annual maintenance items such as rodent control, weed control/management, maintaining gage markers, clearing of trees and brush, replacement/installing riprap, exercising of the outlet steel slide gate, seepage vs. reservoir level monitoring, and updating the emergency action plan.

#### ***E. Lengthier Frequency Items***

**Hazard Classification** – In having the highest dam classification, PLPOA should not expect to have any changes to the Hatcher Dam hazard classification.

**Inundation Mapping** – For a High Hazard dam PLPOA is required to establish and maintain flood inundation mapping for Hatcher Dam. Updates and maintenance of mapping should consider downstream development and changes to the inflow design flood for sizing of the emergency spillway.

**Instrumentation Plan** – For a High Hazard dam, PLPOA is required to maintain survey monuments and piezometers. Surveys of monuments are required every 5 years. PLPOA will need to establish a routine plan to maintain and monitor the piezometer instrumentation.

**Outlet Inspection** – We include costs for PLPOA to perform a Type B outlet inspection every 10 years. This inspection is based on using a remote camera system for video inspection.

**Head Gate Replacement** – We include costs for PLPOA to replace the head gate once during a 100-year period. The estimated date of head gate replacement is 2020.



**F. Outlet Works Replacement/Rehabilitation Items**

As previously discussed, approximately 55% of the operating service life has passed for the Hatcher Dam appurtenances. At this time, we predict a worst-case scenario cost estimate for PLPOA to consider for budgeting:

**Outlet Works Replacement** – Replacement of the reinforced concrete pipe outlet, concrete outlet and steel slide gate. This approach would require partial breach of the dam structure. It is important PLPOA plan this work with PAWSD as they use raw water from Hatcher Lake, as it is the primary water source for the Hatcher Water Treatment Plant. Replacement of the outlet works and controls would restart the operating service life for the replaced structures. Based on the year of Hatcher Dam being placed into service we estimate this work to take place in 2065.

Note: Service maintenance of the reinforced concrete pipe outlet and steel slide gate may be an option PLPOA implements with intermittent emptying of Hatcher Lake. Typical maintenance work would include sealing of concrete, filling of concrete cracks, patching of spalled concrete and replacement of the steel slide gate. We have not included estimates to perform the described service maintenance items as these may not occur at the same time, depend on rate of material deterioration and coordination to empty Hatcher Lake. We expect service maintenance costs be less than the worst-case scenario discussed above.

We have estimated potential costs for items D, E, and F:

<p><b>Maintenance Items (Annual Costs)</b></p>	<ul style="list-style-type: none"> <li>▪ \$2,520/year for rodent control, removal of weeds, brush and trees, maintaining gage markers, maintaining riprap, operating outlet works, monitoring and documenting seepage vs. reservoir levels, and maintaining the emergency action plan</li> </ul>
<p><b>Lengthier Frequency Items (Varying)</b></p>	<ul style="list-style-type: none"> <li>▪ \$1,150 for survey of dam monuments (every 5 years)</li> <li>▪ \$7,500 for Hydrology Report (every 10 years)</li> <li>▪ \$3,360 for Type B Outlet Inspection (every 10 years)</li> <li>▪ \$75,174 for Head Gate Replacement (every 50 years)</li> </ul>
<p><b>Major Dam Outlet Works Replacement 2065</b></p>	<ul style="list-style-type: none"> <li>▪ \$987,042 for Hatcher Dam Outlet Replacement</li> <li>▪ Based on a 100-year operating service life the expected year for the outlet works replacement is 2065</li> </ul>



Linn & Clark Dam (or Lake Pagosa) is PLPOA’s oldest and second largest in size (storage) and has a Significant Hazard Classification. Starting in 1902, storage of water in the structure was for a stock pond. No records or information is available on the dam prior to 1971. According to past reports, in 1971 the dam embankment section was enlarged and widened to accommodate a roadway along the crest. Today, the Linn & Clark Dam is an earthen embankment dam with an emergency overflow spillway across Cloud Cap Avenue, with stored water potentially treated for potable use. At the maximum section of the dam is a steel slide gate on the intake control structure. The intake control structure then moves through the dam embankment structure by a series of 24-inch diameter reinforced concrete pipes to the outlet headwall. Also, three high-level culverts are part of the outlet works for the dam structure.

In reviewing the historical Dam Inspection Reports for Linn & Clark Dam, repeated notes were indicated about the boggyness, and inadequate drainage at the downstream toe. Also noted, is a high-level corrugated metal pipe to be properly abandoned or removed from the right side of the dam structure and has not been addressed. We have included an estimated cost for PLPOA to properly abandon the high-level corrugated metal pipe in place.

**1902**  
 Year Constructed

- Dam Height of 26.7feet
- Storage of 1,120 acre-feet
- Significant Hazard Classification
- 34 Years Old (outlet works recently reconstructed)

**1986**  
 Year of Major Repairs

- Downstream face developed a slip
- Outlet works were noted as non-functioning during annual operations
- Installed new slide gate, outlet pipe, intake structure and headwall

**2006**  
 Last Outlet Inspection

- 24 inch diameter reinforced con. pipe
- 24 inch diameter steel slide gate with gate lift
- Emergency Overflow spillway
- 15 inch CMP outlet pipe
- 18 inch CMP outlet pipe

PLPOA is to consider the following:

- Operating service life of reinforced concrete pipe is 70-100 years according to the American Concrete Pipe Association
- Operating service life of the steel slide gates is 40-50 years in a non-corrosive environment with frequent exercise in discussing with a gate manufacturer
- Operating service life of concrete can vary and is based on the concrete materials used in the mix, reinforcing steel cover and local corrosive elements

*Note: The service life estimates above reflect timely maintenance, proper installation and suitable conditions.*

To date, Linn & Clark Dam is 34 years old (2020-1986). When considering the expected service life of the dam structure components, nearly 34% of the operating service life has been reached for the reinforced concrete outlet pipe and 68% of the operating service life for the steel slide gate. The steel slide gate is past half of its service life and PLPOA should have minimal issues (e.g. leaks or onerous operation) in the future.

### **Linn & Clark Dam Probable Costs**

We have estimated the present value probable costs for annual maintenance items, engineering service items and complete outlet works replacement which is explained below.

#### ***G. Annual Maintenance Items***

As owner of the Linn & Clark Dam, PLPOA is to perform annual maintenance items such as rodent control, weed control/management, maintaining gage markers, clearing of trees and brush, replacement/installing riprap, exercising of the outlet steel slide gate, seepage vs. reservoir level monitoring, and updating the emergency action plan.

#### ***H. Lengthier Frequency Items***

**Hazard Classification** – In having a Significant Hazard dam classification, PLPOA should expect the hazard classification to change in the future to High Hazard as downstream development continues. Engineering support is to be expected in modeling the flood flow and then comparing with downstream development.

**Inundation Mapping** – For a Significant Hazard dam, PLPOA is required to establish and maintain flood inundation mapping for the Linn & Clark Dam. Updates and maintenance of mapping should consider downstream development and changes to the inflow design flood for sizing of the emergency spillway.

**Instrumentation Plan** – For a Significant Hazard dam, PLPOA is required to maintain survey monuments and piezometers. Surveys of monuments are required every 5 years. PLPOA will need to establish a routine plan to maintain and monitor the piezometer instrumentation.

**Outlet Inspection** – We include costs for PLPOA to perform a Type B outlet inspection every 10 years. This inspection is based on using a remote camera system for video inspection.

**Head Gate Replacement** – We include costs for PLPOA to replace the head gate once during a 100-year period. The estimated date of head gate replacement is 2036.

**I. Outlet Works Replacement/Rehabilitation Items**

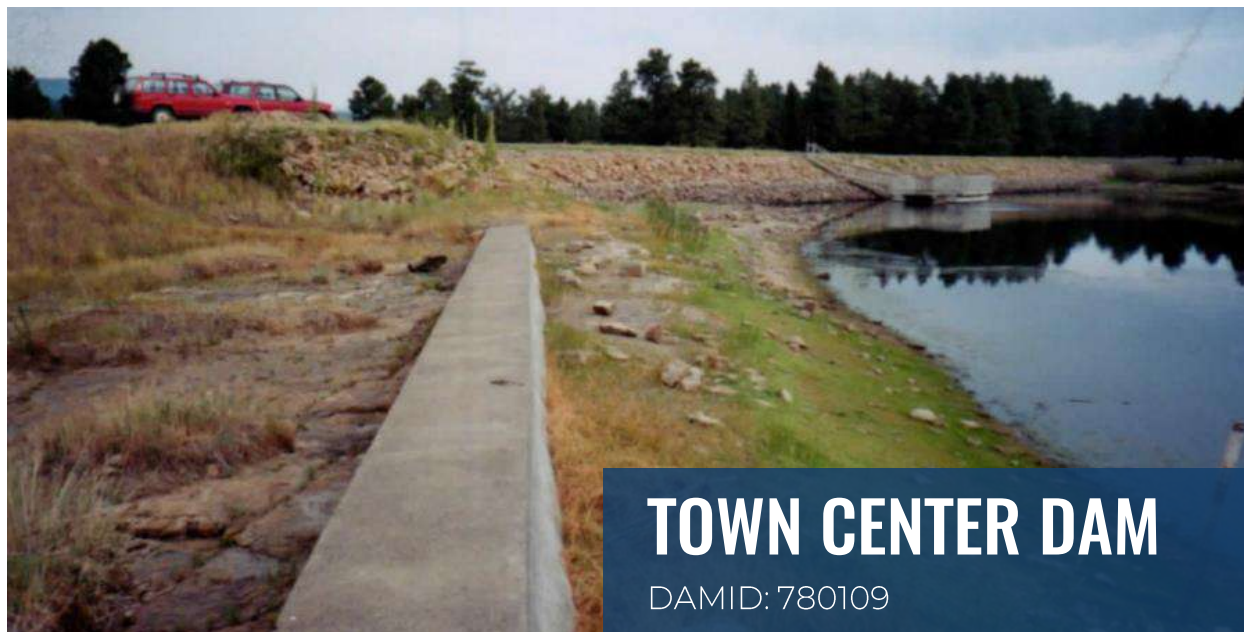
As previously discussed, between 34- 68% of the operating service life has passed for the Linn & Clark Dam appurtenances. At this time, we predict a worst-case scenario cost estimate for PLPOA to consider for budgeting:

**Outlet Works Replacement** – Replacement of the reinforced concrete pipe outlet pipe, concrete intake and steel slide gate controls. This approach would require partial breach of the dam structure. It is important PLPOA plan this work with PAWSD (stored water user) and Archuleta County (Cloud Cap Avenue roadway owner) as impacts would be abrupt. Replacement of the outlet works and controls would restart the operating service life for the structure replaced. This level of replacement work was performed in 1986 and another replacement event would not be expected until 2086. We include within the cost estimate pressure grouting/filling of the existing 15-inch diameter high-level corrugated metal pipe to properly abandon this pipe in place.

Note: Service maintenance of the reinforced concrete pipe outlet and steel slide gate may be an option PLPOA implements with intermittent emptying of Lake Pagosa. Typical maintenance work would include sealing of concrete, filling of concrete cracks, patching of spalled concrete and replacement of the steel slide gate. We have not included estimates to perform the described service maintenance items as these may not occur at the same time, depend on rate of material deterioration and coordination to empty Lake Pagosa. We expect service maintenance costs be less than the worst-case scenario discussed above.

We have estimated potential costs for items G, H, and I:

<p><b>Maintenance Items (Annual Costs)</b></p>	<ul style="list-style-type: none"> <li>▪ \$2,520/year for rodent control, removal of weeds, brush and trees, maintaining gage markers, maintaining riprap, operating outlet works, monitoring and documenting seepage vs. reservoir levels, and maintaining the emergency action plan</li> </ul>
<p><b>Lengthier Frequency Items (Varying)</b></p>	<ul style="list-style-type: none"> <li>▪ \$1,150 for survey of dam monuments (every 5 years)</li> <li>▪ \$6,750 for Hazard Class. Report (every 10 years)</li> <li>▪ \$7,500 for Hydrology Report (every 10 years)</li> <li>▪ \$3,360 for Type B Outlet Inspection (every 10 years)</li> <li>▪ \$75,174 for Head Gate Replacement (every 50 years)</li> </ul>
<p><b>Major Dam Outlet Works Replacement 2086</b></p>	<ul style="list-style-type: none"> <li>▪ \$536,725 for Linn &amp; Clark Dam Outlet Replacement</li> <li>▪ Based on a 100-year operating service life the expected year for the outlet works replacement is 2086</li> </ul>



Town Center Dam (or Village Lake) is PLPOA’s third largest in size (storage) and has a Significant Hazard Classification. Town Center Dam is an earthen embankment dam with an emergency overflow spillway below North Pagosa Boulevard. At the maximum section of the dam is a steel sluice gate at the intake control structure. The intake control structure then continues through the dam embankment structure by a concrete encased 24-inch diameter CMP to the outlet headwall. Recent rehabilitation work was performed to add a cured in-place pipe (CIPP) liner material inside the corroded 24-inch diameter CMP.

In reviewing the historical Dam Inspection Reports for the Town Center Dam, repeated notes were indicated about seepage at the downstream toe. Recommendations by dam inspectors have been made to install a v-notch weir to quantify discharge for seepage monitoring which has not been completed. To date the drain outlets have not been located to monitor seepage amounts.

**1973**  
Year Constructed

- Dam Height of 40 feet
- Storage of 585 acre-feet
- Significant Hazard Classification
- 47 Years Old

**2015**  
Year of CIPP Liner

- Encased CMP was severely corroded
- CIPP Liner installed in the outlet and overflow pipe locations
- CIPP Liner adhesion was problematic with future plans to reapply another layer

**2006**  
Last Outlet Inspection

- 24 inch diameter CMP encased in concrete
- 24 inch sluice gate
- Emergency Overflow spillway
- 24 inch diameter CMP ungated high level outlet pipe

PLPOA is to consider the following:

- Operating service life of corrugated metal pipe is 28-30 years according to the service life of the previous pipe
- Operating service life of cured in-place pipe liner is 40-50 year according to the EPA in evaluation of CIPP liners used in municipal gravity sewer applications
- Operating service life of the steel slide gates is 40-50 years in a non-corrosive environment with frequent exercise in discussing with a gate manufacturer
- Operating service life of concrete can vary and is based on the concrete materials used in the mix, reinforcing steel cover and local corrosive elements

*Note: The service life estimates above reflect timely maintenance, proper installation and suitable conditions.*

To date, Town Center Dam is 47 years old (2020-1973). When considering the expected service life of the dam structure components, nearly 47% of the operating service life has been reached for the reinforced concrete outlet pipe and 94% of the operating service life for the steel sluice gate. The steel sluice gate is at the end of its service life and PLPOA is to expect issues (e.g. leaks or onerous operation) in the near future.

### **Town Center Dam Probable Costs**

We have estimated the present value probable costs for annual maintenance items, engineering service items and complete outlet works replacement which is explained below.

#### ***J. Annual Maintenance Items***

As owner of the Town Center Dam, PLPOA is to perform annual maintenance items such as rodent control, weed control/management, maintaining gage markers, clearing of trees and brush, replacement/installing riprap, exercising of the outlet sluice gate, seepage vs. reservoir level monitoring, and updating the emergency action plan.

#### ***K. Lengthier Frequency Items***

**Hazard Classification** – In having a Significant Hazard dam classification, PLPOA should expect the hazard classification to change in the future to High Hazard as downstream development continues with time. Engineering support is to be expected in modeling the flood flow and comparing with downstream development.

**Inundation Mapping** – For a Significant Hazard dam, PLPOA is required to establish and maintain flood inundation mapping for the Linn & Clark Dam. Updates and maintenance of mapping should consider downstream development and changes to the inflow design flood for sizing of the emergency spillway.

**Instrumentation Plan** – For a Significant Hazard dam, PLPOA is required to maintain survey monuments and piezometers. Surveys of monuments will be required every 5 years. PLPOA will need to establish a routine plan to maintain and monitor the piezometer instrumentation.

**Outlet Inspection** – We include costs for PLPOA to perform a Type B outlet inspection every 10 years. This inspection is based on using a remote camera system for video inspection.

**Head Gate Replacement** – We include costs for PLPOA to replace the head gate once during a 100-year period. The estimated date of head gate replacement is 2023.

**L. Outlet Works Replacement/Rehabilitation Items**

As previously discussed, between 47- 94% of the operating service life has passed for the Town Center Dam appurtenances. At this time, we predict a worst-case scenario cost estimate for PLPOA to consider for budgeting:

**Outlet Works Replacement** – Replacement of the concrete encased 24-inch diameter CMP outlet pipe, concrete intake and steel slide gate controls. This approach would require partial breach of the dam structure. It is important PLPOA plan this work with PAWSD (stored water user) and Archuleta County (North Pagosa Boulevard roadway owner) as impacts would be abrupt. Replacement of the outlet works and controls would restart the operating service life for the replaced structures. If protection of the 24-inch diameter CMP is successful in the future with the CIPP liner then we would expect replacement of the outlet structure to be delayed. Maintenance in the form of protecting existing infrastructure lengthens the service life of dam appurtenances. Based on the year of Town Center Dam being placed into service we estimate this work to take place in 2073.

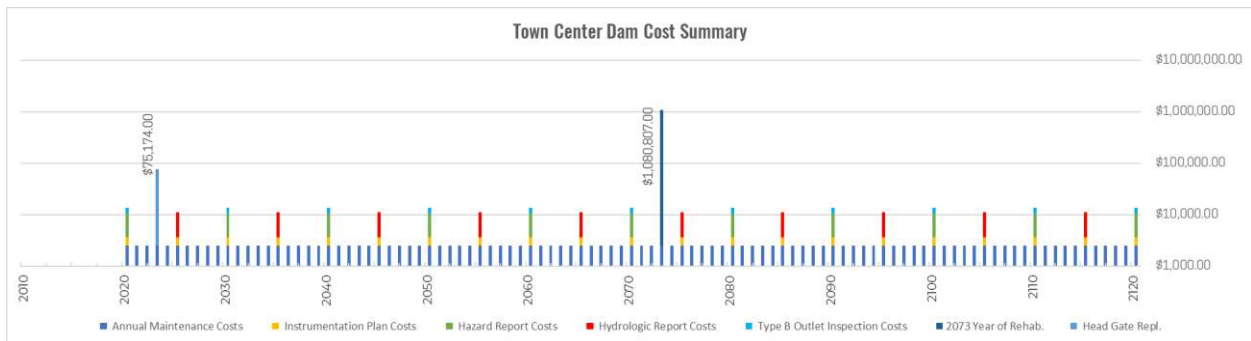
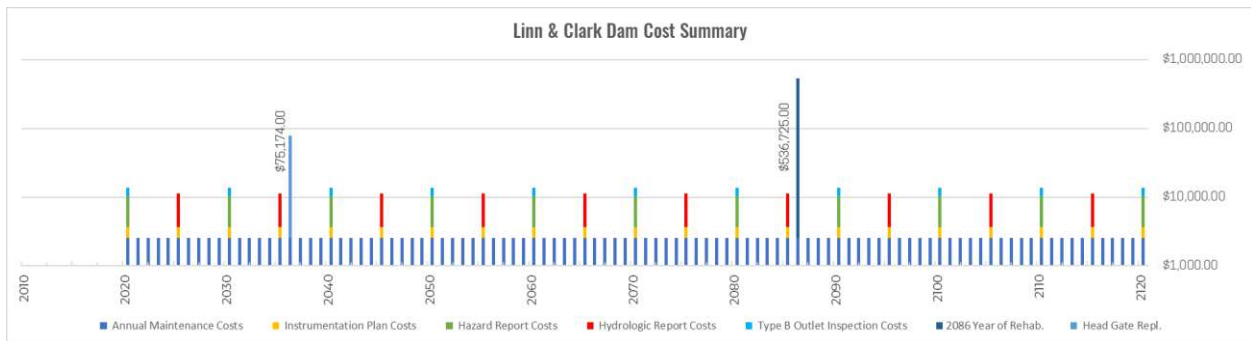
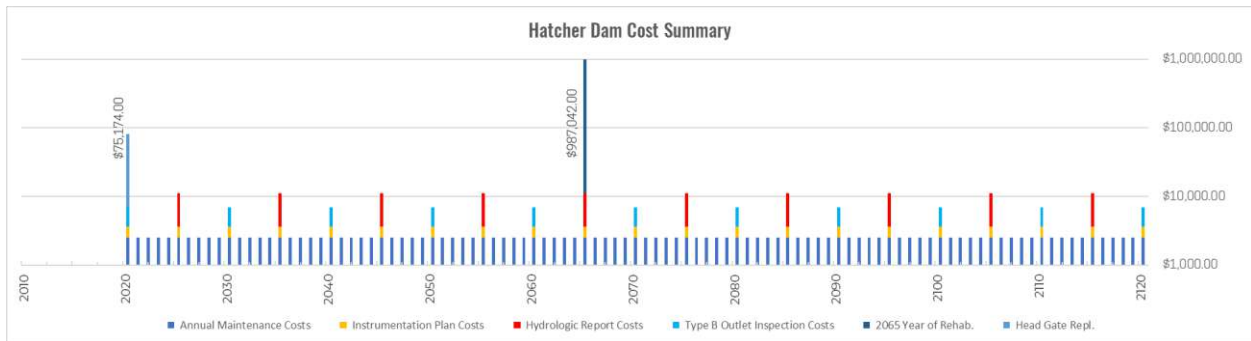
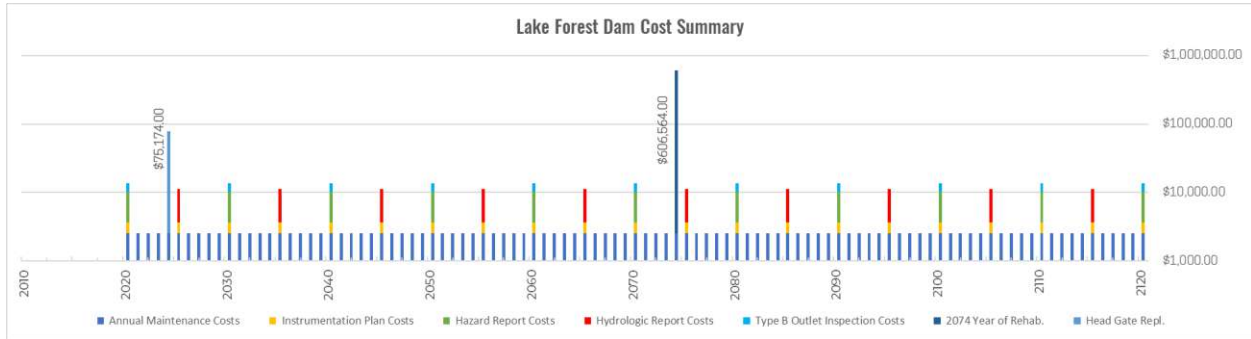
Note: Service maintenance of the reinforced concrete structures and steel sluice gate may be an option PLPOA implements with intermittent emptying of Village Lake. Typical maintenance work would include sealing of concrete, filling of concrete cracks, patching of spalled concrete and replacement of the steel slide gate. We have not included estimates to perform the described service maintenance items as these may not occur at the same time, depend on rate of material deterioration and coordination to empty Village Lake. We expect service maintenance costs be less than the worst-case scenario discussed above.

We have estimated potential costs for items J, K, and L:

<b>Maintenance Items (Annual Costs)</b>	<ul style="list-style-type: none"> <li>▪\$2,520/year for rodent control, removal of weeds, brush and trees, maintaining gage markers, maintaining riprap, operating outlet works, monitoring and documenting seepage vs. reservoir levels, and maintaining the emergency action plan</li> </ul>
<b>Lengthier Frequency Items (Varying)</b>	<ul style="list-style-type: none"> <li>▪\$1,150 for survey of dam monuments (every 5 years)</li> <li>▪\$6,750 for Hazard Class. Report (every 10 years)</li> <li>▪\$7,500 for Hydrology Report (every 10 years)</li> <li>▪\$3,360 for Type B Outlet Inspection (every 10 years)</li> <li>▪\$75,174 for Head Gate Relacement (every 50 years)</li> </ul>
<b>Major Dam Outlet Works Replacement 2073</b>	<ul style="list-style-type: none"> <li>▪\$1,080,807 for Town Center Dam Outlet Replacement</li> <li>▪Based on a 100-year operating service life the expected year for the outlet works replacement is 2073</li> </ul>

### Graphs of Probable Costs

The timelines below depict the annual maintenance costs, engineering service item costs, and complete replacement of the outlet works for each dam. Each timeline horizontal axis fixed between 1960 through 2120 to compare probable costs.





## Summary

Overall, it is estimated that the service life of PLPOA's dam appurtenances is around 50%. Age is an important consideration when budgeting for major repair work or maintenance. To avoid costly and unplanned work associated with the dams, PLPOA is to consider the following:

- **Document Changes to Material Surfaces** – We recommend concrete and pipe surfaces be visually reviewed at each dam location. Reinforced concrete pipe, corrugated metal pipes, headwalls, intake structures and walkways should be visually reviewed and then documented. Use of photography is helpful in understanding material conditions and changes.
- **Document Seepage vs Reservoir Levels** – We recommend a plan be developed to monitor seepage amounts with reservoir levels at each dam. Dam structures are exposed to seasonal variations (e.g. spring run-off from winter conditions, extreme drought conditions, monsoon rain events). A monitoring plan will keep you familiar with annual and seasonal seepage trends.
- **Exercise Steel Gates/Sluices** – We recommend gates be operated 4-6 times a year. Additionally, personnel, should document when exercising is performed along with recording their observations. Visual review of each dam's slide or sluice gate does not take place due to lake reservoir levels. The best practice of ensuring gates and sluices are functional is to exercise them.
- **Maintain and Update Hazard and Hydrologic Reports** – We recommend Hazard Reports be updated to ensure sizing of dam components meet the requirements of the dam's respective hazard classification. Additionally, we recommend Hydrologic Reports be updated to predict and model the inflow design flood. It should be noted the State of Colorado will be making changes to precipitation modeling requirements used in dam design and changes may impact sizing of dam components. Historically, PLPOA's dams were built during a time where downstream areas were undeveloped. Dam owners are responsible in the maintenance and protection of dam structures to ensure safety of downstream structures and occupants.

We understand PLPOA and Pagosa Area Water and Sanitation District (PAWSD) share maintenance roles and responsibilities; and use of stored water. For instance, PAWSD has water rights for water stored by Hatcher Dam. With other stakeholders having interest in the storage of water by PLPOA's dams, consider the following:

- **Memorandum of Understanding (MOU)** – Dam ownership is very costly and storage restrictions are burdensome when in effect. Unplanned draining of reservoirs also can be very problematic to users. We recommend PAWSD and PLPOA partner together in planning and handling of future or emergency repair work. MOU's clarify roles, responsibilities and expectations for planned or unplanned events. Additionally, shared roles and expectations can be established for annual maintenance and monitoring of dam appurtenances.

# APPENDIX A

## ANNUAL MAINTENANCE & OPERATING COST ESTIMATE

# DAM MAINTENANCE & OPERATING COSTS

## ARCHULETA COUNTY, COLORADO

PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Prepared By: Davis Engineering Service, Inc.

Prepared January 2, 2020

DESCRIPTION	UNIT	QUANTITY	ENGINEER'S ESTIMATE	
			UNIT PRICE	EXTENSION
<b>ANNUAL MAINTENANCE COSTS (ONE DAM)</b>				
RODENT CONTROL (2 PEOPLE @ 8 HOURS)	L.S.	1	\$ 560.00	\$ 560.00
WEED CONTROL/MOWING (2 PEOPLE @ 8 HOURS)	L.S.	1	\$ 560.00	\$ 560.00
MAINTAINING GAGE MARKERS (1 PERSON @ 4 HOURS)	L.S.	1	\$ 140.00	\$ 140.00
CLEARING OF TREES & BRUSH (2 PEOPLE @ 8 HOURS)	L.S.	1	\$ 560.00	\$ 560.00
REPLACING/INSTALLING RIPRAP (1 PERSON @ 4 HOURS)	L.S.	1	\$ 140.00	\$ 140.00
OPERATING OUTLET WORKS (1 PERSON @ 4 HOURS)	L.S.	1	\$ 140.00	\$ 140.00
MONITORING SEEPAGE VS. RES. LEVEL (1 PERSON @ 8 HOURS)	L.S.	1	\$ 280.00	\$ 280.00
MAINTAIN EMERGENCY ACTION PLAN/NOTIFICATION LIST	L.S.	1	\$ 140.00	\$ 140.00
<b>ANNUAL COST TOTAL</b>			<b>\$</b>	<b>2,520.00</b>
<b>INSTRUMENTATION PLAN (ONE DAM, EVERY 5 YEARS)</b>				
SURVEY OF DAM MONUMENTS	L.S.	1	\$ 1,150.00	\$ 1,150.00
<b>INSTRUMENTATION PLAN TOTAL</b>			<b>\$</b>	<b>1,150.00</b>
<b>HAZARD CLASSIFICATION REPORT (ONE DAM, EVERY 10 YEARS)</b>				
UPDATE & MAINTAIN CLASSIFICATION & INUNDATION MAPPING	L.S.	1	\$ 6,750.00	\$ 6,750.00
<b>INUNDATION MAPPING TOTAL</b>			<b>\$</b>	<b>6,750.00</b>
<b>HYDROLOGY REPORT (ONE DAM, EVERY 10 YEARS)</b>				
REVIEW OUTLET WORKS CAPACITY FOR CHANGES IN IDF	L.S.	1	\$ 7,500.00	\$ 7,500.00
<b>HAZARD CLASSIFICATION TOTAL</b>			<b>\$</b>	<b>7,500.00</b>
<b>TYPE B OUTLET INSPECTION (ONE DAM, EVERY 10 YEARS)</b>				
CAMERA INSPECTION OF OUTLET PIPE	L.S.	1	\$ 3,360.00	\$ 3,360.00
<b>OUTLET INSPECTION TOTAL</b>			<b>\$</b>	<b>3,360.00</b>

Note: The cost estimate above represents the best judgment of the Engineer as a design professional familiar with the construction industry, but in no way guarantees that bids, proposals or construction costs will not vary from the prepared estimate.

# APPENDIX B

HEAD GATE REPLACEMENT (GENERIC FOR EACH DAM)

COST ESTIMATE

# HEAD GATE REPLACEMENT COST (GENERIC FOR EACH DAM)

## ARCHULETA COUNTY, COLORADO

PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Prepared By: Davis Engineering Service, Inc.

Prepared January 13, 2020

The estimate below represents costs to remove and replace one head gate. For the purposes of the Dam Condition Study the service life of a head gate is estimated as being approximately 50 years. Appurtenances include, but not limited to, valve stem, oil encasement pipe, oil seal packing assembly, anchor bolts, pipe clamps, nuts and washers. Estimate includes repairs to the concrete outlet structure, but not replacement. This estimate is included within the lengthier frequency items for each of PLPOA's dams and estimates replacement of the largest slide gate (24-inch diameter) configuration where other locations are smaller.

DESCRIPTION	UNIT	QUANTITY	ENGINEER'S ESTIMATE	
			UNIT PRICE	EXTENSION
<b>CONSTRUCTION COSTS</b>				
REMOVAL OF EXISTING GATE & MATERIALS	EA.	1	\$ 5,000.00	\$ 5,000.00
CONCRETE SEALING (CRACKS)	L.F.	20	\$ 10.00	\$ 200.00
CONCRETE SEALER (SURFACE)	S.F.	150	\$ 30.00	\$ 4,500.00
CONCRETE PATCHING	S.F.	10	\$ 125.00	\$ 1,250.00
COFFERDAM & DEWATERING	L.S.	1	\$ 9,000.00	\$ 9,000.00
SLIDE GATE & APPURTENANCES, VARIES	EA.	1	\$ 32,000.00	\$ 32,000.00
MOBILIZATION & DEMOBILIZATION	L.S.	1	\$ 3,500.00	\$ 3,500.00
BONDING	L.S.	1	\$ 1,500.00	\$ 1,500.00
<b>ANNUAL COST TOTAL</b>				<b>\$ 56,950.00</b>

<b>PROJECT DESIGN &amp; DEVELOPMENT</b>				
CONTINGENCY (5%)	L.S.	1	\$ 2,847.50	\$ 2,847.50
PRELIMINARY ENGINEERING (5%)	L.S.	1	\$ 2,847.50	\$ 2,847.50
DESIGN ENGINEERING (10%)	L.S.	1	\$ 5,695.00	\$ 5,695.00
CONSTRUCTION ENGINEERING (10%)	L.S.	1	\$ 5,695.00	\$ 5,695.00
MATERIALS TESTING (0%)	L.S.	1	\$ 1,139.00	\$ 1,139.00
<b>PROJECT DEVELOPMENT SUBTOTAL</b>				<b>\$ 18,224.00</b>
<b>TOTAL PROJECT COST</b>				<b>\$ 75,174.00</b>

Note: The cost estimate above represents the best judgment of the Engineer as a design professional familiar with the construction industry, but in no way guarantees that bids, proposals or construction costs will not vary from the prepared estimate.

Estimates for engineering costs are estimated at 10% due to rigorous Dam Safety Branch design review process and changes to the Rules and Regulation for Dam Safety and Construction.

# APPENDIX C

LAKE FOREST DAM – OUTLET WORKS REPLACEMENT

COST ESTIMATE

# LAKE FOREST DAM - OUTLET WORKS REPLACEMENT

## ARCHULETA COUNTY, COLORADO

PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Prepared By: Davis Engineering Service, Inc.

Prepared January 2, 2020

The estimate below represents a worst case scenario, being a partial dam breach with outlet works replacement projecting to take place in 2074.

DESCRIPTION	UNIT	QUANTITY	ENGINEER'S ESTIMATE	
			UNIT PRICE	EXTENSION
<b>CONSTRUCTION COSTS</b>				
REINFORCED CONCRETE OUTLET PIPE, 72" DIAMETER	L.F.	165	\$ 600.00	\$ 99,000.00
PERFORATED PVC DRAIN PIPE, 4" DIAMETER	L.F.	80	\$ 10.00	\$ 800.00
CONCRETE ANTI-SEEP COLLARS	EA.	7	\$ 6,250.00	\$ 43,750.00
CONCRETE OUTLET STRUCTURE, U/S	L.S.	1	\$ 30,000.00	\$ 30,000.00
CONCRETE OUTLET STRUCTURE, D/S	L.S.	1	\$ 4,000.00	\$ 4,000.00
CONCRETE HANDWHEEL STRUCTURE	L.S.	1	\$ 5,000.00	\$ 5,000.00
CONCRETE VALVE STEM SUPPORTS	EA.	3	\$ 400.00	\$ 1,200.00
FILTER MATERIAL, DIAPHRAGM & COLLAR	C.Y.	45	\$ 80.00	\$ 3,600.00
EXCAVATION & EMBANKMENT, DAM BREACH	C.Y.	3,200	\$ 30.00	\$ 96,000.00
RIPRAP, REMOVE & REPLACE	C.Y.	205	\$ 30.00	\$ 6,150.00
TEMPORARY EROSION CONTROL	L.S.	1	\$ 2,500.00	\$ 2,500.00
TOPSOIL, REMOVE & REPLACE	C.Y.	95	\$ 8.00	\$ 760.00
SEEDING & MULCHING	ACRE	1	\$ 3,000.00	\$ 3,000.00
RECONSTRUCT ROADWAY	S.Y.	250	\$ 130.00	\$ 32,500.00
EXISTING OUTLET DEMOLITION & REMOVAL	L.S.	1	\$ 8,000.00	\$ 8,000.00
COFFERDAM & DEWATERING	L.S.	1	\$ 40,000.00	\$ 40,000.00
SLIDE GATE & APPURTENANCES, 20" DIAMETER	L.S.	1	\$ 32,000.00	\$ 32,000.00
TRASHRACK FOR U/S OUTLET STRUCTURE	L.S.	1	\$ 3,500.00	\$ 3,500.00
TRASHRACK FOR SERVICE SPILLWAY STRUCTURE	L.S.	1	\$ 1,500.00	\$ 1,500.00
MOBILIZATION & DEMOBILIZATION	L.S.	1	\$ 16,000.00	\$ 16,000.00
BONDING	L.S.	1	\$ 4,000.00	\$ 4,000.00
<b>CONSTRUCTION SUBTOTAL</b>				<b>\$ 433,260.00</b>
<b>PROJECT DESIGN &amp; DEVELOPMENT</b>				
CONTINGENCY (15%)	L.S.	1	\$ 64,989.00	\$ 64,989.00
PRELIMINARY ENGINEERING (3%)	L.S.	1	\$ 12,997.80	\$ 12,997.80
DESIGN ENGINEERING (10%)	L.S.	1	\$ 43,326.00	\$ 43,326.00
CONSTRUCTION ENGINEERING (10%)	L.S.	1	\$ 43,326.00	\$ 43,326.00
MATERIALS TESTING (2%)	L.S.	1	\$ 8,665.20	\$ 8,665.20
<b>PROJECT DEVELOPMENT SUBTOTAL</b>				<b>\$ 173,304.00</b>
<b>TOTAL PROJECT COST</b>				<b>\$ 606,564.00</b>

Note: The cost estimate above represents the best judgment of the Engineer as a design professional familiar with the construction industry, but in no way guarantees that bids, proposals or construction costs will not vary from the prepared estimate.

Estimates for engineering costs are estimated at 10% due to rigorous Dam Safety Branch design review process and changes to the Rules and Regulation for Dam Safety and Construction.

# APPENDIX D

HATCHER DAM – OUTLET WORKS REPLACEMENT

COST ESTIMATE



# HATCHER DAM - OUTLET WORKS REPLACEMENT

## ARCHULETA COUNTY, COLORADO

PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Prepared By: Davis Engineering Service, Inc.

Prepared January 2, 2020

The estimate below represents a worst case scenario, being a partial dam breach with outlet works replacement projecting to take place in 2065.

DESCRIPTION	UNIT	QUANTITY	ENGINEER'S ESTIMATE	
			UNIT PRICE	EXTENSION
<b>CONSTRUCTION COSTS</b>				
DUCTILE IRON OUTLET PIPE, 18" DIAMETER	L.F.	285	\$ 120.00	\$ 34,200.00
PERFORATED PVC DRAIN PIPE, 4" DIAMETER	L.F.	104	\$ 10.00	\$ 1,040.00
STANDARD SCHEDULE STEEL OUTLET PIPE, 18" DIAMETER	L.F.	15	\$ 250.00	\$ 3,750.00
CONCRETE PIPE ENCASEMENT	L.S.	1	\$ 25,000.00	\$ 25,000.00
CONCRETE OUTLET STRUCTURE, U/S	L.S.	1	\$ 5,500.00	\$ 5,500.00
CONCRETE OUTLET STRUCTURE, D/S	L.S.	1	\$ 3,000.00	\$ 3,000.00
CONCRETE HANDWHEEL STRUCTURE	L.S.	1	\$ 5,000.00	\$ 5,000.00
CONCRETE VALVE STEM SUPPORTS	EA.	9	\$ 400.00	\$ 3,600.00
FILTER MATERIAL, DIAPHRAGM & COLLAR	C.Y.	40	\$ 80.00	\$ 3,200.00
EXCAVATION & EMBANKMENT, DAM BREACH	C.Y.	18,500	\$ 25.00	\$ 462,500.00
RIPRAP, REMOVE & REPLACE	C.Y.	690	\$ 30.00	\$ 20,700.00
TEMPORARY EROSION CONTROL	L.S.	1	\$ 2,500.00	\$ 2,500.00
TOPSOIL, REMOVE & REPLACE	C.Y.	255	\$ 8.00	\$ 2,040.00
SEEDING & MULCHING	ACRE	1.5	\$ 3,000.00	\$ 4,500.00
EXISTING OUTLET DEMOLITION & REMOVAL	L.S.	1	\$ 4,000.00	\$ 4,000.00
COFFERDAM & DEWATERING	L.S.	1	\$ 60,000.00	\$ 60,000.00
SLIDE GATE & APPURTENANCES, 18" DIAMETER	L.S.	1	\$ 32,000.00	\$ 32,000.00
TRASHRACK FOR U/S OUTLET STRUCTURE	L.S.	1	\$ 2,500.00	\$ 2,500.00
MOBILIZATION & DEMOBILIZATION	L.S.	1	\$ 24,000.00	\$ 24,000.00
BONDING	L.S.	1	\$ 6,000.00	\$ 6,000.00
<b>CONSTRUCTION SUBTOTAL</b>				<b>\$ 705,030.00</b>
<b>PROJECT DESIGN &amp; DEVELOPMENT</b>				
CONTINGENCY (15%)	L.S.	1	\$ 105,754.50	\$ 105,754.50
PRELIMINARY ENGINEERING (3%)	L.S.	1	\$ 21,150.90	\$ 21,150.90
DESIGN ENGINEERING (10%)	L.S.	1	\$ 70,503.00	\$ 70,503.00
CONSTRUCTION ENGINEERING (10%)	L.S.	1	\$ 70,503.00	\$ 70,503.00
MATERIALS TESTING (2%)	L.S.	1	\$ 14,100.60	\$ 14,100.60
<b>PROJECT DEVELOPMENT SUBTOTAL</b>				<b>\$ 282,012.00</b>
<b>TOTAL PROJECT COST</b>				<b>\$ 987,042.00</b>

Note: The cost estimate above represents the best judgment of the Engineer as a design professional familiar with the construction industry, but in no way guarantees that bids, proposals or construction costs will not vary from the prepared estimate.

Estimates for engineering costs are estimated at 10% due to rigorous Dam Safety Branch design review process and changes to the Rules and Regulation for Dam Safety and Construction.

# APPENDIX E

LINN & CLARK DAM – OUTLET WORKS REPLACEMENT

COST ESTIMATE

# LINN & CLARK (LAKE PAGOSA) DAM - OUTLET WORKS REPLACEMENT

## ARCHULETA COUNTY, COLORADO

PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Prepared By: Davis Engineering Service, Inc.

Prepared January 2, 2020

The estimate below represents a worst case scenario, being a partial dam breach with outlet works replacement projecting to take place in 2086. Also, included is a cost to abandon

DESCRIPTION	UNIT	QUANTITY	ENGINEER'S ESTIMATE	
			UNIT PRICE	EXTENSION
<b>CONSTRUCTION COSTS</b>				
DUCTILE IRON OUTLET PIPE, 24" DIAMETER	L.F.	215	\$ 170.00	\$ 36,550.00
PERFORATED PVC DRAIN PIPE, 4" DIAMETER	L.F.	78	\$ 10.00	\$ 780.00
STANDARD SCHEDULE STEEL OUTLET PIPE, 24" DIAMETER	L.F.	15	\$ 335.00	\$ 5,025.00
CONCRETE PIPE ENCASMENT	L.S.	1	\$ 24,000.00	\$ 24,000.00
CONCRETE OUTLET STRUCTURE, U/S	L.S.	1	\$ 7,000.00	\$ 7,000.00
CONCRETE OUTLET STRUCTURE, D/S	L.S.	1	\$ 4,000.00	\$ 4,000.00
CONCRETE HANDWHEEL STRUCTURE	L.S.	1	\$ 5,000.00	\$ 5,000.00
CONCRETE VALVE STEM SUPPORTS	EA.	3	\$ 400.00	\$ 1,200.00
FILTER MATERIAL, DIAPHRAGM & COLLAR	C.Y.	45	\$ 80.00	\$ 3,600.00
EXCAVATION & EMBANKMENT, DAM BREACH	C.Y.	5,750	\$ 25.00	\$ 143,750.00
PREESURE GROUT & FILL 15" DIAMETER OUTLET PIPE	L.S.	1	\$ 15,000.00	\$ 15,000.00
REMOVE ENDS & CAP 15" DIAMETER OUTLET PIPE	L.S.	1	\$ 5,000.00	\$ 5,000.00
RIPRAP, REMOVE & REPLACE	C.Y.	250	\$ 30.00	\$ 7,500.00
TEMPORARY EROSION CONTROL	L.S.	1	\$ 2,500.00	\$ 2,500.00
TOPSOIL, REMOVE & REPLACE	C.Y.	140	\$ 8.00	\$ 1,120.00
SEEDING & MULCHING	ACRE	1	\$ 3,000.00	\$ 3,000.00
RECONSTRUCT ROADWAY	S.Y.	290	\$ 65.00	\$ 18,850.00
EXISTING OUTLET DEMOLITION & REMOVAL	L.S.	1	\$ 4,000.00	\$ 4,000.00
COFFERDAM & DEWATERING	L.S.	1	\$ 40,000.00	\$ 40,000.00
SLIDE GATE & APPURTUENANCES, 24" DIAMETER	L.S.	1	\$ 32,000.00	\$ 32,000.00
TRASHRACK FOR U/S OUTLET STRUCTURE	L.S.	1	\$ 3,500.00	\$ 3,500.00
MOBILIZATION & DEMOBILIZATION	L.S.	1	\$ 16,000.00	\$ 16,000.00
BONDING	L.S.	1	\$ 4,000.00	\$ 4,000.00
<b>CONSTRUCTION SUBTOTAL</b>				<b>\$ 383,375.00</b>
<b>PROJECT DESIGN &amp; DEVELOPMENT</b>				
CONTINGENCY (15%)	L.S.	1	\$ 57,506.25	\$ 57,506.25
PRELIMINARY ENGINEERING (3%)	L.S.	1	\$ 11,501.25	\$ 11,501.25
DESIGN ENGINEERING (10%)	L.S.	1	\$ 38,337.50	\$ 38,337.50
CONSTRUCTION ENGINEERING (10%)	L.S.	1	\$ 38,337.50	\$ 38,337.50
MATERIALS TESTING (2%)	L.S.	1	\$ 7,667.50	\$ 7,667.50
<b>PROJECT DEVELOPMENT SUBTOTAL</b>				<b>\$ 153,350.00</b>
<b>TOTAL PROJECT COST</b>				<b>\$ 536,725.00</b>

Note: The cost estimate above represents the best judgment of the Engineer as a design professional familiar with the construction industry, but in no way guarantees that bids, proposals or construction costs will not vary from the prepared estimate.

# APPENDIX F

TOWN CENTER DAM – OUTLET WORKS REPLACEMENT

COST ESTIMATE

# TOWN CENTER DAM - OUTLET WORKS REPLACEMENT

## ARCHULETA COUNTY, COLORADO

PAGOSA LAKES PROPERTY OWNERS ASSOCIATION

Prepared By: Davis Engineering Service, Inc.

Prepared January 2, 2020

The estimate below represents a worst case scenario, being a partial dam breach with outlet works replacement projecting to take place in 2073.

DESCRIPTION	UNIT	QUANTITY	ENGINEER'S ESTIMATE	
			UNIT PRICE	EXTENSION
<b>CONSTRUCTION COSTS</b>				
DUCTILE IRON OUTLET PIPE, 24" DIAMETER	L.F.	260	\$ 170.00	\$ 44,200.00
PERFORATED PVC DRAIN PIPE, 4" DIAMETER	L.F.	100	\$ 10.00	\$ 1,000.00
STANDARD SCHEDULE STEEL OUTLET PIPE, 24" DIAMETER	L.F.	15	\$ 335.00	\$ 5,025.00
CONCRETE PIPE ENCASEMENT	L.S.	1	\$ 24,000.00	\$ 24,000.00
CONCRETE OUTLET STRUCTURE, U/S	L.S.	1	\$ 30,000.00	\$ 30,000.00
CONCRETE OUTLET STRUCTURE, D/S	L.S.	1	\$ 4,000.00	\$ 4,000.00
CONCRETE SERVICE SPILLWAY STRUCTURE	L.S.	1	\$ 2,000.00	\$ 2,000.00
CONCRETE HANDWHEEL STRUCTURE	L.S.	1	\$ 5,000.00	\$ 5,000.00
CONCRETE VALVE STEM SUPPORTS	EA.	3	\$ 400.00	\$ 1,200.00
FILTER MATERIAL, SLOPE BLANKET	C.Y.	95	\$ 80.00	\$ 7,600.00
FILTER MATERIAL, DIAPHRAGM & COLLAR	C.Y.	45	\$ 80.00	\$ 3,600.00
EXCAVATION & EMBANKMENT, DAM BREACH	C.Y.	14,000	\$ 25.00	\$ 350,000.00
CURED IN-PLACE PIPE LINER	L.F.	260	\$ 275.00	\$ 71,500.00
UPSTREAM CURED IN-PLACE LINER SEAL	L.S.	1	\$ 10,000.00	\$ 10,000.00
RIPRAP, REMOVE & REPLACE	C.Y.	525	\$ 30.00	\$ 15,750.00
TEMPORARY EROSION CONTROL	L.S.	1	\$ 2,500.00	\$ 2,500.00
TOPSOIL, REMOVE & REPLACE	C.Y.	235	\$ 8.00	\$ 1,880.00
SEEDING & MULCHING	ACRE	1.5	\$ 3,000.00	\$ 4,500.00
RECONSTRUCT ROADWAY	S.Y.	425	\$ 130.00	\$ 55,250.00
EXISTING OUTLET DEMOLITION & REMOVAL	L.S.	1	\$ 8,000.00	\$ 8,000.00
COFFERDAM & DEWATERING	L.S.	1	\$ 60,000.00	\$ 60,000.00
SLIDE GATE & APPURTENANCES, 24" DIAMETER	L.S.	1	\$ 32,000.00	\$ 32,000.00
TRASHRACK FOR U/S OUTLET STRUCTURE	L.S.	1	\$ 3,500.00	\$ 3,500.00
TRASHRACK FOR SERVICE SPILLWAY STRUCTURE	L.S.	1	\$ 1,500.00	\$ 1,500.00
MOBILIZATION & DEMOBILIZATION	L.S.	1	\$ 24,000.00	\$ 24,000.00
BONDING	L.S.	1	\$ 4,000.00	\$ 4,000.00
<b>CONSTRUCTION SUBTOTAL</b>				<b>\$ 772,005.00</b>
<b>PROJECT DESIGN &amp; DEVELOPMENT</b>				
CONTINGENCY (15%)	L.S.	1	\$ 115,800.75	\$ 115,800.75
PRELIMINARY ENGINEERING (3%)	L.S.	1	\$ 23,160.15	\$ 23,160.15
DESIGN ENGINEERING (10%)	L.S.	1	\$ 77,200.50	\$ 77,200.50
CONSTRUCTION ENGINEERING (10%)	L.S.	1	\$ 77,200.50	\$ 77,200.50
MATERIALS TESTING (2%)	L.S.	1	\$ 15,440.10	\$ 15,440.10
<b>PROJECT DEVELOPMENT SUBTOTAL</b>				<b>\$ 308,802.00</b>
<b>TOTAL PROJECT COST</b>				<b>\$ 1,080,807.00</b>

Note: The cost estimate above represents the best judgment of the Engineer as a design professional familiar with the construction industry, but in no way guarantees that bids, proposals or construction costs will not vary from the prepared estimate.

Estimates for engineering costs are estimated at 10% due to rigorous Dam Safety Branch design review process and changes to the Rules and Regulation for Dam Safety and Construction.