

PROJECT PROFILE



Silver Creek Dam Monitoring and Emergency Warning System, Silverton, Oregon

Client:

City of Silverton, Oregon

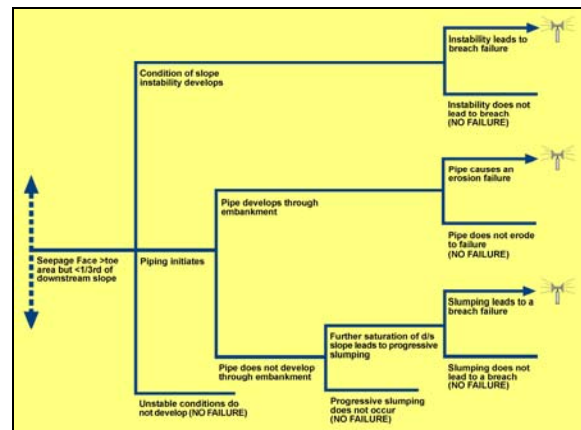
The Silver Creek Dam is located roughly two miles upstream from downtown Silverton, Oregon. The dam and reservoir are owned and operated by the City of Silverton and were constructed in the late 1970's to provide raw water storage and recreational uses for the City. The crest length of the dam is 680 feet, and it has a maximum height of 65 feet. The dam is constructed as a zoned earth embankment dam with a 3H:1V upstream slope, a 2H:1V downstream slope and a central core.

The results of Dam Break Analyses indicated that a flood wave in excess of 10 feet would travel down the Silver Creek channel and inundate downtown Silverton within 15 minutes following a breach failure of the dam. Based on these results, the City of Silverton decided to implement an early warning system for the dam. The purpose of the early warning

system is to provide advanced notice so that the inhabitants can be safely evacuated from the flood inundation area.

Engineered Monitoring Solutions conducted a design study for an early warning system with the objective of identifying improvements that can be made to the existing monitoring program that will allow for early warning of an imminent failure condition with sufficient time to evacuate all persons within the downstream inundation area.

To provide early warning of an imminent failure condition, the potential modes of failure, and more importantly the events that led to the failure, had to be understood. Therefore, failure modes analysis was used to identify the events that could be detected by the early warning system to provide notification of a developing condition, and to design a detection system that would monitor for these conditions.



Silver Creek Dam Monitoring and Emergency Warning System (continued)

The system improvements include the following:

- Reservoir water level monitoring to detect a high or rapidly rising reservoir level condition.
- Outfitting existing piezometers with sensors to detect changes in the seepage performance of the dam and abutments.
- Installing weir box instruments to collect and monitor seepage for changes in flow.
- Installing an On Site Monitoring Station to provide a base station at the dam for on-site monitoring during a “Developing” alarm condition.
- Installing a Reservoir Level Site Gauge to provide a back-up point of reference for visual monitoring of the reservoir level during a flooding condition.

All of the electronic sensors are connected to Measurement Control Units (MCU's). The MCU's are microprocessor controlled data acquisition units that will be programmed to collect the data from the sensors and compare the readings to predetermined threshold values every 15 minutes. If a threshold value is exceeded, then the MCU network will initiate a phone call to the assigned city personnel to alert of a developing condition of concern. City personnel will then respond according to the City's Emergency Action Plan.

The recommended notification system will consist of an outdoor siren network consisting of 4 outdoor sirens and a personal notification procedure for special facilities and those with disabilities. In addition to the sirens and personal notification, certain procedures and polices such as notification flow charts, on-going testing, maintenance, and public education, will be implemented to assure proper operation of the notification system.

Table 1. Silver Creek Dam Alarm Response Plan

ALARM LEVEL	SAFETY CONDITION	RESPONSE
ALERT	DEVELOPING CONDITION OF CONCERN <ul style="list-style-type: none"> • Piezometer level exceeds high threshold values • Weir flows exceed high threshold values • Reservoir level within 8 feet of crest • Earthquake occurs • Network communication error 	<ul style="list-style-type: none"> • Operator on duty notified immediately by cell phone and uses the Monitoring Station PC to evaluate the alarm condition • Operator conducts a site visit to observe the conditions that caused the alarm • If the alarm is not the result of an equipment malfunction, then the operator remains on site to monitor for a developing unstable condition
DEVELOPING	UNSTABLE CONDITION DEVELOPS <ul style="list-style-type: none"> • Instability develops on the downstream slope • Sinkhole develops on the upstream slope • Uncontrolled seepage exiting at the downstream toe or abutment contacts • Structural failure allows uncontrolled seepage around spillway • High reservoir level results in seepage through the upper 4.5 feet of the embankment • Debris in the spillway reduces capacity and causes a sudden rise in reservoir level 	<ul style="list-style-type: none"> • Operator initiates the emergency call out list to issue a "warning" of an unstable condition • Operator continues to monitor the situation from the On-Site Monitoring Station • Engineering evaluation is immediately conducted • Warning condition is removed when the alarm conditions return to a normal level, or actions have been taken to successfully stabilize the situation
CRITICAL	IMMINENT FAILURE CONDITION <ul style="list-style-type: none"> • Instability incorporates half of the downstream slope • Sinkhole or sinkhole on the upstream slope reduces the freeboard to less than 4.5 feet • Whirlpool develops in the reservoir • Turbid flow is exiting the downstream toe or abutment areas at an increasing rate • Reservoir level rises to within 2 feet of the crest • Erosion/slumping occurs in the upper 4.5 feet of the embankment under high reservoir levels 	<ul style="list-style-type: none"> • Operator activates the notification system from the On-Site Monitoring Station "Silver Creek Dam emergency. Evacuate the Flood Hazard Zone Immediately!" • Evacuation Plan is initiated • All clear notification "Silver Creek Dam is Secure, it is safe to return." is activated when the condition has been stabilized or the flood wave has passed

Because of the short lead time to notify inhabitants in the flood inundation area, this project represents the importance of using failure modes analysis in the design process to identify the appropriate monitoring objectives. By enhancing the City's existing dam safety monitoring equipment versus replacing current equipment, Engineered Monitoring Solutions will bring thousands in cost savings to the City.