# Surface Water Contamination and Los Alamos National Laboratory's Holistic Approach to Mitigation - 9497

*D. Katzman, S. Veenis, Los Alamos National Laboratory, Water Stewardship Program,*
*S. Reneau, Los Alamos National Laboratory, Earth and Environmental Science Division,*
*P.O. Box 1663, MS M992, Los Alamos, New Mexico, 87545*

## ABSTRACT

A sediment and contaminant transport mitigation project is being implemented at Los Alamos National Laboratory. This effort is driven by a requirement from State of New Mexico regulators and is also in concert with efforts underway to support a surface-water diversion project by a Santa Fe, NM, public water utility. The effort is being implemented in a large geomorphically and hydrologically complex watershed. Rather than simply attempting to trap sediment in a retention basin, this effort uses a watershed-scale holistic approach with intent to promote watershed healing.

## INTRODUCTION

The Los Alamos and Pueblo watershed, including Los Alamos and Pueblo Canyons and their tributaries, includes several current and former technical areas (TAs) at Los Alamos National Laboratory (LANL or the Laboratory). Investigations of the nature, extent, transport, and potential risk from chemicals of potential concern (COPCs) in the watershed were conducted from 1997 to 2004 [1]. The results of these investigations indicate no human-health or ecological risk above regulatory standards is present from residual contaminants that remain in sediments. However, in response to a requirement from state regulators (the New Mexico Environment Department or NMED) to address polychlorinated biphenyl (PCB) contamination and in concert with the Laboratory's desire to improve water quality within a major tributary to the Rio Grande, where a surface-water diversion project is planned for the City of Santa Fe and Santa Fe County, a sediment mitigation plan has been developed.

Portions of this watershed have been listed as "impaired waters" by the NMED Surface Water Quality Bureau pursuant to Section 303(d) of the Clean Water Act (CWA). It is expected that actions taken under this plan will be part of mitigations activities that will support the total maximum daily loads (TMDL) process currently underway at the Laboratory.

Although actions are being taken in both Los Alamos and Pueblo Canyons, this paper presents information and the work being conducted only within Pueblo Canyon. A complete presentation of actions throughout the watershed is provided in two work plans submitted to the NMED [2,3].

## CONCEPTUAL MODEL

The conceptual model presented below is specific to PCBs, but the actions described in the mitigation activities section below are expected to mitigate transport of other adsorbed contaminants present in the watershed. Key aspects of the conceptual model include (1) sources and current distribution of PCBs, (2) sources of runoff, (3) sediment particle-size effects, and (4) sediment deposition areas. Locations of investigation reaches, TAs, gaging stations, and other sites discussed in this section are shown in Figure 1.

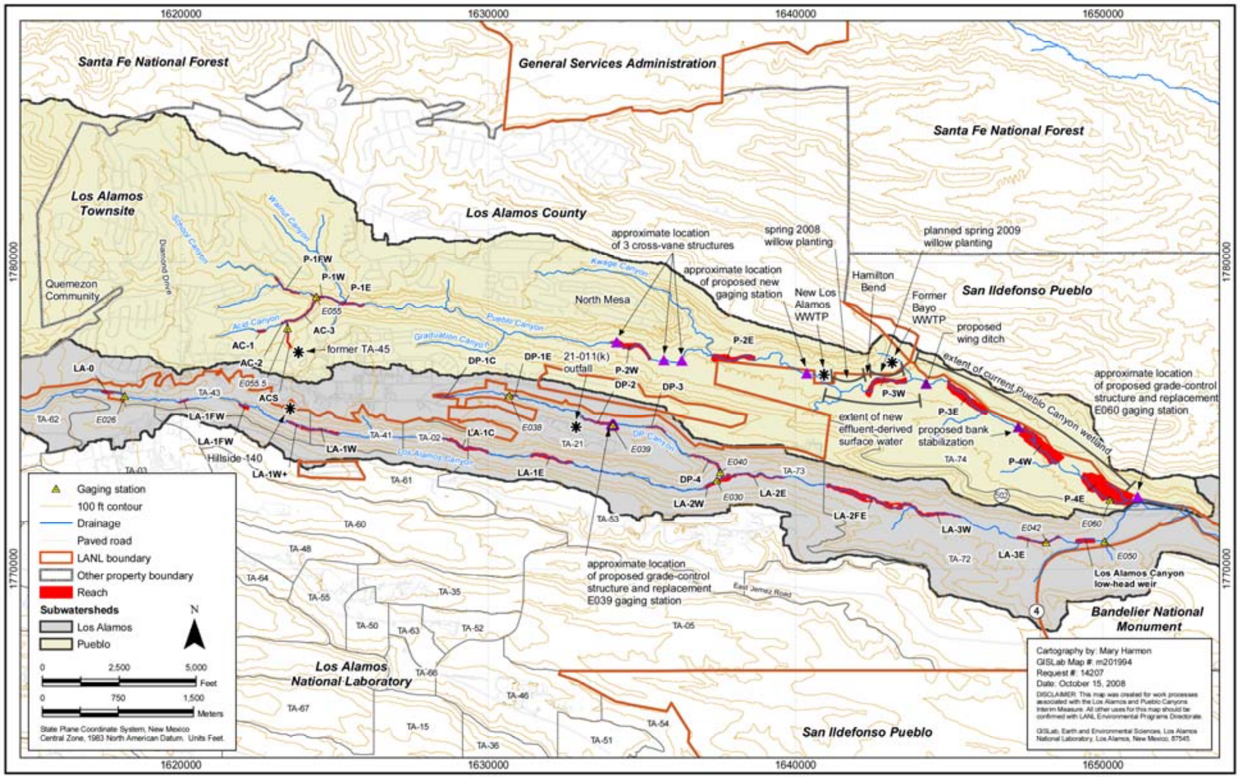


Figure 1 Los Alamos and Pueblo watershed and sediment investigation reaches (red polygons), Technical Areas, gaging stations, and other features discussed in text.

## Pueblo Canyon Wetland

The headwaters portions of the Los Alamos/Pueblo watershed were significantly affected by the Cerro Grande fire in May 2000. Complete or partial removal of thick forest groundcover (duff) created a temporary perturbation in the runoff response to typical summer precipitation [4]. Increased frequency and magnitude of runoff caused erosion of a formally stable and extensive wetland that is supported by effluent from the Los Alamos County wastewater treatment plant (Figure 2) [5,6]. Stable, thickly vegetated portions of the wetland have shown substantial potential to trap sediment and adsorbed contaminants (Figure 2). The deposition in the wetland is enhanced by thick vegetation (particularly reed canary grass, *Phalaris arundinacea*), which adds roughness and decelerates the flow. A potential detriment to such aggradation is noted by field observations that indicate that one effect of this deposition has been an increase in the elevation of the floodplain relative to the channel bed, in turn reducing the frequency of overbank flooding. At present, most of the floods do not appear to go out of bank in many areas, which reduces the potential for deposition of sediment and associated contaminants. For deposition in these areas to increase, floodwaters would have to go overbank more frequently. These principles form the foundation of the proposed actions described in detail later in this paper.

(a)

(b)

Figure 2 (a) Photograph of headcut and eroded channel within the Pueblo Canyon wetland and (b) photograph of approximately 1 meter of post-fire sediment aggradation resulting from trapping efficiency in stable, vegetated portions of wetland. Dark ash-rich sediment layer is visible at base of excavation.

### Sources and Current Distribution of PCBs in Pueblo Canyon

PCBs are widely distributed in sediment deposits in the Los Alamos and Pueblo watershed, and their spatial distribution indicates they have multiple sources, including both Laboratory and non-Laboratory (Los Alamos townsite) sources.

Erosion of sediment deposits in the canyon bottom containing PCBs is probably the primary source, at present, of continued PCB transport in stormwater in the Los Alamos and Pueblo watershed. Data on PCB concentrations and sediment volumes were used to estimate the inventory of PCBs in Pueblo Canyon. Although PCB contamination is present at very low concentrations in sediment throughout the watershed, most of the inventory is located predominantly in the upper portion of the canyon near the original sources.

### Sources of Runoff in Pueblo Canyon

Although runoff from the Cerro Grande burn area was initially the source of large runoff events for several years after the fire, rainfall patterns and stream discharge records indicate that at present the most important source for stormwater in Pueblo Canyon is urban runoff. The Los Alamos townsite has become a more important source for runoff in Pueblo Canyon after the Cerro Grande fire because of residential development and because of construction of a large culvert that allows runoff from the burned upland portion of the watershed to pass unimpeded. Erosion and sediment transport in Pueblo Canyon is thus enhanced by urban runoff, and controlling urban runoff may help reduce downstream sediment and contaminant transport.

## PLANNED MITIGATION ACTIONS

The fundamental approach of the sediment transport mitigation efforts in Pueblo Canyon is to stabilize the wetland to sustain its sediment-trapping efficiency while also reducing the potential erosive energy of floods generated in the upper watershed, including portions of the Los Alamos townsite.

The transport of PCBs and other contaminants associated with sediment in stormwater can be reduced in three ways: (1) reduce the magnitude and/or frequency of runoff events; (2) reduce the erosion of contaminated sediment deposits during runoff events; or (3) enhance sediment deposition during runoff events. The following actions address each of these three processes, with an emphasis on the enhancement of sediment deposition. These actions are described in greater detail in two regulatory work plans prepared by the Laboratory [2,3].

### Stabilization and Enhancement of Pueblo Canyon Wetland

The Pueblo Canyon wetland serves the valuable function of dissipating flood energy and allowing suspended sediment and adsorbed contaminants to be deposited. Several actions are planned to stabilize and enhance the wetland. These include (1) constructing a base-level grade-control structure to stabilize the lower end of the wetland; (2) planting willows along the channel below the new Los Alamos County wastewater treatment plant outfall to increase the upstream extent of wetland vegetation; (3) installing cross-vane structures to reduce flood energy, and (4) constructing a pilot wing ditch to evaluate the feasibility of spreading water in the wetland and enhancing sediment deposition. The gaging station network would also be expanded and improved to help measure the effectiveness of the enhanced wetland in reducing transport of suspended sediment and associated contaminants. One new gaging station would be constructed upcanyon from the wetland, and the existing downcanyon gaging station (E060) would be relocated to a point downstream from the grade-control structure.

**Grade-Control Structure**

The grade-control structure will be located in lower Pueblo Canyon in the vicinity of the NM 4–NM 502 interchange at the eastern end of the wetland (Figure 3). Conceptually, the proposed structure may utilize a basic design of above-grade rock-and-mesh gabions spanning the width of the active channel and adjacent abandoned channels and active floodplains. The height of the structure will be designed to allow the currently incised channel to backfill with sediment and establish a new grade that eventually buries the headcuts at the terminus of the wetland. In the process, the current incised channel will be replaced with a broad aggraded wetland surface where floodwaters would spread and further increase sediment deposition. The objective of the grade-control structure is to extend and stabilize the downcanyon extent of the wetland and is not intended to be a sediment-trapping basin that would require periodic excavation to meet its design objective.

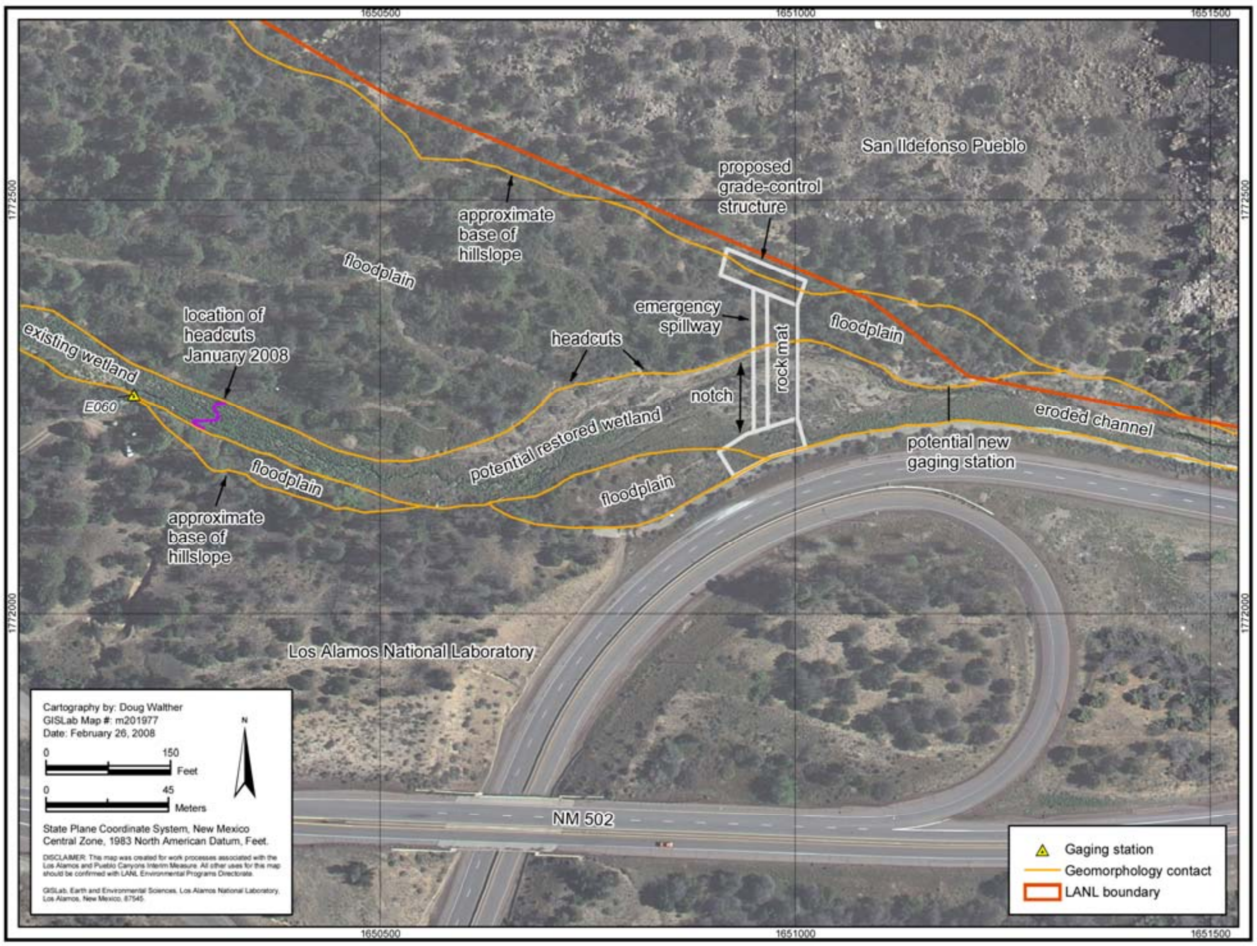


Figure 3 Orthophotograph of lower Pueblo Canyon showing location of proposed grade-control structure, proposed new E060 gaging station, and headcuts near current E060 gaging station

**Upstream Enhancement of Wetland**

The Pueblo Canyon wetland will also be extended upcanyon though implementation of two steps. The first step was rerouting of the Los Alamos County (LAC) wastewater treatment plant outfall (Figure 1). The Laboratory coordinated with LAC during design of a new treatment plant location to move the outfall upcanyon approximately 1 km to establish potential for additional bank-stabilizing riparian conditions. The next step involved planting approximately 3000 native willow stems (*Salix spp*.) along the newly wetted channel and floodplain. This work has the combined goals of stabilizing surfaces, dissipating flood energy, increasing sediment deposition, and enhancing ecological habitat.

### Cross-Vane Structures

Cross-vane structures will be established in the Pueblo Canyon channel upcanyon of the wetland area. The primary objective is to decrease flood peaks before floods enter the downstream wetland. The structures are planned to be constructed from large boulders set within the channel in a "V" configuration (Figure 4) with appropriate boulder spacing that will allow relatively unimpeded passage of low flows but that will reduce the erosive discharge associated with the rising limb of flood hydrographs. The structures may also locally enhance deposition of sediment.


Figure 4 Conceptualized elements of cross-vane structures planned for Pueblo Canyon upcanyon of the wetland

Three separate structures will be placed within the Pueblo Canyon channel. The segment of Pueblo Canyon was selected for these structures based on channel morphology and bank height. Cross-vane structures are considered most effective within open, relatively wide channel and floodplain settings. Each structure will consist of a single row of approximately 5- to 10-ft-diameter boulders buried approximately one-third below grade and placed in a configuration of the cross-vane weir. Individual boulders will be spaced approximately one-half the boulder diameter apart.

### Pilot Wing Ditch

The Laboratory proposes constructing a pilot wing ditch in the part of the Pueblo Canyon wetland in reach P-3E (Figure 1) to enhance the spreading of water over the wetland, dissipate flood energy, and enhance deposition of suspended sediment. The ditch will extend to approximately one-half the depth of the existing channel to intercept and divert runoff that would otherwise remain within the banks and not interact with adjacent floodplains. The downstream reentry point(s) for the dispersed water will be monitored and stabilized as needed (e.g., if new headcuts formed). If the pilot wing ditch is successful, remains stable, and has no unintended adverse consequences, additional similar structures may be constructed in the wetland. However, if it is unsuccessful, the ditch will be backfilled.

### Stormwater Management

Runoff from urban areas in the Los Alamos townsite contributes significantly to flood discharge and therefore to downstream erosion and sediment transport in Los Alamos and Pueblo Canyons. Los Alamos County recognizes this problem and has taken steps to manage stormwater. These steps include a revision to the County's engineering standards and proposed changes to the County Development Code. Additional projects to reduce peak flows were developed and implemented through a CWA Section 319 grant to the Pajarito Plateau Watershed Partnership. The Laboratory will continue to coordinate with LAC to address stormwater management in the Los Alamos and Pueblo watershed, as appropriate and feasible.

## MONITORING PROGRAM

The effectiveness of the actions discussed in this paper will be evaluated using stream discharge data and sampling and analysis of stormwater collected upcanyon and downcanyon from the primary sediment deposition areas. In Pueblo Canyon, discharge will be measured and samples collected at a new gaging station upcanyon from the new Los Alamos wastewaster treatment plant and at a relocated E060 gaging station, to be located downcanyon from the proposed grade-control structure (Figure 1).

A stormwater sampling program will be established to ensure that important variables such as suspended-sediment concentrations will be consistent between stations [7,8]. These data will be combined with discharge measurements to calculate flux of suspended sediment and associated contaminants.

## REFERENCES

1. LANL (Los Alamos National Laboratory), "Los Alamos and Pueblo Canyons Investigation Report," Los Alamos National Laboratory document LA-UR-04-2714, (April 2004).

2. LANL (Los Alamos National Laboratory), "Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons", LA-UR-08-1071, (February 2008).

3. LANL (Los Alamos National Laboratory), "Supplemental Interim Measures Work Plan to Mitigate Contaminated Sediment Transport in Los Alamos and Pueblo Canyons", LA-UR-08-6588, (October 2008).

4. Gallaher, B.M., and R.J. Koch, “Cerro Grande Fire Impacts to Water Quality and Stream Flow near Los Alamos National Laboratory: Results of Four Years of Monitoring,” Los Alamos National Laboratory report LA-14177, (September 2004).

5. Ford-Schmid, R., and D. Englert, “Post Cerro Grande Fire Stream Channel Morphology in Lower Pueblo Canyon, Reach P-4 East, Los Alamos County, New Mexico,” Department of Energy Oversight Bureau, New Mexico Environment Department, Santa Fe, New Mexico. (January 2004).

6. Lyman, J., S.L. Reneau, D. Katzman, A. Lavine, and D.V. Malmon (Los Alamos National Laboratory), “Characterization of Erosion and Deposition of Sediment in Pueblo Canyon, Los Alamos, New Mexico, Following the Cerro Grande Fire,” Los Alamos National Laboratory report LA-14231, (June 2005).

7. Malmon, D.V., S.L. Reneau, and T. Dunne, 2004. “Sediment Sorting and Transport by Flash Floods,” *Journal of Geophysical Research,* Vol. 109, F02005, 13 pp. (2004)

8. Malmon, D.V., S.L. Reneau, D. Katzman, A. Lavine, and J. Lyman, 2007. “Suspended Sediment Transport in an Ephemeral Stream Following Wildfire,” *Journal of Geophysical Research,* Vol. 112, F02006, 16 pp. (2007)