Figure 5-1. Entrance to Water Treatment Plant (ground motion estimated by field observations)

Figure 5-2. Settling and Filter Basin Structures

Figure 5-3. Two partially buried clearwells

Figure 5-4. Damaged control building

The chemical tanks rocked (Fig. 5-5), leading to damage of attached PVC pipes (Fig. 5-6). The four small plastic stops did restrain the tank from sliding, but not from rocking. The rocking led to damage of the attached restrained PVC pipe.

Figure 5-5. Plastic tank for chlorine dioxide disinfectant

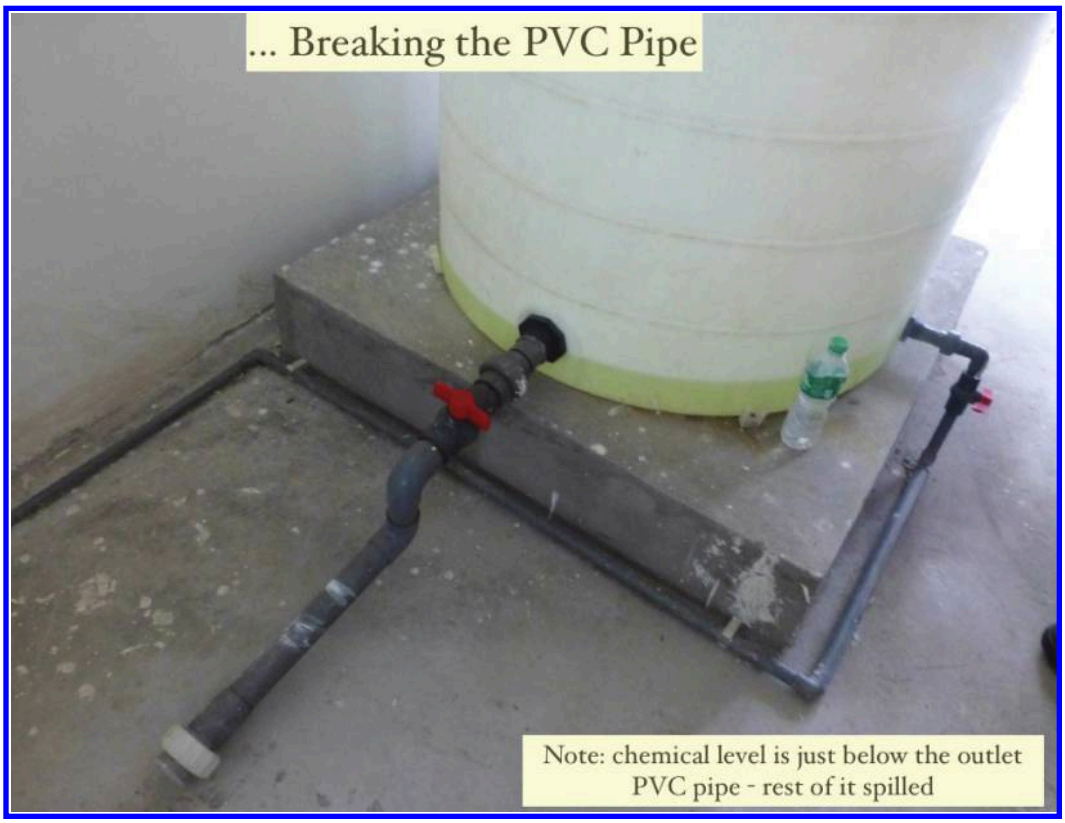

Figure 5-6. Broken PVC pipe (the motor and pump also broke and have been removed)

5.2 Water Distribution Pipes

Lushan City has about 300 km of water distribution pipes. Most are cast iron (dating back more than 50 years). The newer pipes are PVC. Most distribution pipes are 100 mm in diameter; 500 mm in diameter is the largest pipe in the system. Figure 5-7 shows a TCLEE team member at a fire hydrant. Note the temporary office buildings in the background. Dozens of such buildings were placed on main city streets in Lushan City to provide needed services, such as life insurance, telecom, and banking.

There were zero reported fire ignitions in Lushan City. It is common to use propane for cooking, and some buildings have natural gas supply. The lack of fire ignitions suggests a few possible changes to U.S. practice. Perhaps the lack of ignitions was due to the widespread power outages (lasting at least 28 hours in Lushan City). Hence the HAZUS fire ignition model should be reviewed and updated.

Figure 5-7. Fire hydrant in Lushan City (John Eidinger)

As of six weeks post-earthquake, no attempt had yet been made by the local public works (water) department to locate the damage to buried water pipes. Responding to our

inquiry, city officials that there was no money and that they were waiting for the government to take care of this. City officials also noted that they have a functioning temporary water system and that all resources have been devoted to providing housing due to widespread damage or destruction of housing units. One reason for this lack of effort to repair the buried pipe is related to the PLA installation of the above-ground water pipe network for most of the city immediately post-earthquake (Fig. 5-8). It took the PLA 1 week to place the temporary water lines for the majority of the city and an additional week to complete the temporary network. It took longer to place the system in the outskirts of the city, despite its smaller population.

Figure 5-8. Above ground temporary water pipe

As a result of this above-ground network, nearly every resident is able to gather water from the hose bibs off these pipes, for gray-water/sanitary purposes. Residents of Lushan and nearby Ya'an traditionally boil all water from the water pipeline system; therefore water from the above ground system could also be used for potable purposes. Emergency response also included use of bottled water delivery for drinking water.

Immediately after the earthquake the people could not purify water due to loss of power. There was a public health concern until power was restored. However, there was no reported outbreak of water borne disease after the earthquake.

6 WASTEWATER

Lushan City has a wastewater collection system and one wastewater treatment plant. The collection system has several lift stations. Due to the loss of power, the lift stations were inoperable and sewage could not be collected immediately after the earthquake, at least in some areas. The TCLEE team was not able to investigate the sewage treatment plant; however, the Lushan City managers reported the plant, which was built within the last year was not significantly damaged.

Several manholes were raised (floated) up to a few centimeters above the sidewalk level in the eastern New Town part of the city (Fig. 6-1). At one location, a set of portable pumps and a hose were being used to pump sewage between manholes, presumably due to a blockage.

Figure 6-1. Floated manhole

There were dozens of portable toilets in use, six weeks after the earthquake (Fig. 6-2).

City staff reported there were no sewage backups to the street level.

Figure 6-2. Portable toilets

7 ROADS AND BRIDGES

The Lushan earthquake damaged many roads, which resulted in severe traffic congestion in some areas. The loss of critical roadways combined with traffic congestion on the few usable roads severely affected emergency response capabilities in the damage region.

The area affected by the Lushan earthquake has steep mountainous terrain and narrow river canyons and valleys. Many roadways are cut into the steep slopes. These steep slopes are also highly susceptible to landsliding and rock falls when subjected to strong ground motions. As a result, the roads are highly susceptible to landslide damage. The two-lane paved road shown in Figure 7-1 was closed by landslides / rock falls, and the road was repaired to one-lane gravel status a month after the earthquake. Even so, local officials were prohibiting access to such roads even a month after the earthquake for fear of continued landslides should there be rain.

Figure 7-1. Typical terrain for roads in the mountainous areas near Lushan (photo late May 2013)

Figure 7-2 shows a map of important transportation routes in the Lushan earthquake affected area. Preliminary reports identified four Highways (G5, S8, S9, and G4201), two National and Provincial main lines (G318, S210) and six County Roads (X073, X074, Z001-Y004, XT26, XT27, XT06) that were damaged by either subgrade collapse, subsidence, landslides, or rock falls.

Figure 7-2. Map of roads and highways in Lushan earthquake damage area, some areas of severe problems noted for G318, G108, and S210 (Courtesy Dr. LIU Aiwen of CEA)

In addition, there were numerous damaged bridges, including serious damage to an arch bridge. Figure 7-3 shows damage to S210 Feixianguan (飞仙关) Road from large boulders.

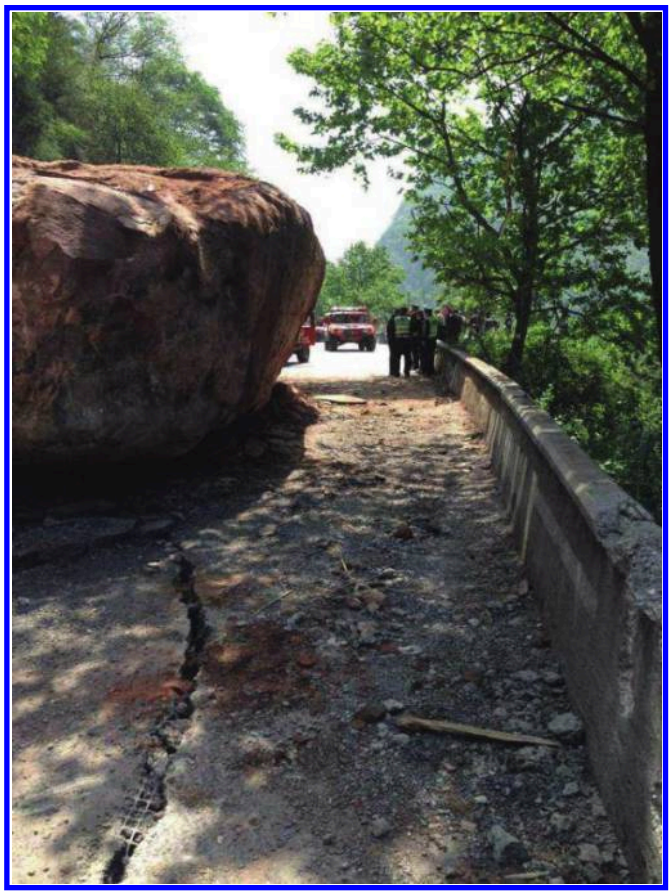

Figure 7-3. S210 damage on Feixianguan (飞仙关) Road by large boulders (Courtesy Dr. LIU Aiwen of CEA)

Figure 7-4 shows damage to S210 Ling Guan (灵关) Road from landslide debris sliding onto the roadway.

Figure 7-4. S210 Ling Guan Road damaged and blocked from landslide debris (Courtesy Dr. LIU Aiwen of CEA)