NATIONAL GUARD ENGINEERS REPAIR

by
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CIVIL CONSIDERATIONS

AS WE KNOW, the motto of the Engineer Regiment is Essayons or "Let us try!" September 2013 will be remembered in the Colorado counties of Boulder and Larimer as a month in which that motto was tested and proven true to its word: we came, we tried, we accomplished! Record-setting rains caused catastrophic flooding along Colorado's Front Range, particularly in the area of Boulder County. A state disaster emergency was declared on 13 September. U.S. Highway 36 required repair in several places along a 25-mile stretch between Lyons and Estes Park. The community of Pinewood Springs, located between Lyons and Estes Park, was completely cut off with few services and no schools because of the damage. By the end of the project, National Guard engineers from Task Force (TF) Pioneer had repaired 25 miles of road, 28 days ahead of the most optimistic schedule of the Colorado Department of Transportation (CDOT).

Because of time constraints and the need for specialized work, the Emergency Management Assistance Compact (EMAC) was enacted. EMAC is a national mutual-aid partnership agreement that allows state-to-state assistance during state- or federally declared emergencies. EMAC is about governors helping fellow governors in times of need. When state resources are overwhelmed, other states, to include National Guard units nationwide, can step in and fill shortfalls. In responding to national emergencies and disasters, EMAC is instrumental in providing needed advice and assistance to governors as it relates to identifying, selecting, requesting, and deploying all types of resources.

As part of the EMAC response, the Utah Army National Guard's 1457th EN BN Headquarters with the 116th EN Co. (Horizontal) were activated as TF Pioneer under Utah state active-duty orders to provide mission command and Army engineer forces. This was part of an overall strategy to increase engineer expertise and staff capability and, most importantly, to complete the road before winter weather made construction impossible at more than 8,000 feet in elevation. TF Pioneer took mission

▶ *National Guard engineers respond to Colorado flooding.*

command of the project on 4 October from the 147th Brigade Support Battalion which was operating as a hybrid mission command staff.

Compounding the emergency flood problem in mid-September was the looming federal government shutdown that occurred in October 2013 and lasted 16 days. National Guard support to flood relief continued on schedule. As a result of the shutdown, Colorado governor John Hickenlooper announced the authorization of state funds to keep National Guard members working on flood recovery efforts. "We can't afford to lose one day in rebuilding areas destroyed or damaged by the floods," Hickenlooper said. "Our National Guard troops are an invaluable part of the team working on the recovery. We need them to stay on the job."

MISSION COMMAND AND TASK ORGANIZATION

Both Army and Air National Guard engineer assets were activated from Colorado, Utah, Montana, and Kansas. By project end, 378 soldiers and airmen from twelve disparate units and varied MTOE missions were activated. In addition to the joint-service organization of the task force, inter-agency support between CDOT and the task force was facilitated through an Army Engineer Coordination Cell (ECC). The ECC was organized to provide technical liaison, Army expertise, synchronization, and quality control. This cell was led by a Colorado National Guard Army engineer lieutenant colonel, employed by the U.S. DOT as a federal highway engineer in the civilian sector. Imagery from ARSST 28, Company 217, 117th Space Support Battalion ("Space Cowboys"), was incorporated into the ECC providing real-time imagery for construction planning and safety throughout the road damage between Lyons and Estes Park. Joint TF Centennial Liaisons integrated into the Colorado Departments of Safety and Environment Protection to provide environmental protection, public safety control, and interservice coordination. JTF Centennial also provided all logistic planning for aoldier and airmen life and administrative support.

TF Pioneer brought a doctrinal Army engineer staff with "S" shops (1–6) to provide mission command. Additionally, a construction management cell within the S-3 shop provided technical engineer and design-build capability. In addition to Army Engineer School–qualified engineer officers and NCOs, TF Pioneer/1457th EN BN brought soldiers with special talents and experience to the mission. The construction management cell within the battalion staff included soldiers with advanced education and experience in their communities as licensed civil engineers. Each unit included soldiers, airmen, and, most importantly, leaders able to operate heavy machinery, drive trucks, and repair equipment in their civilian employment. The Montana unit (219th RED HORSE) was led by a senior NCO who is employed in the civilian community as a local county road superintendent and an NCO with civilian experience as a landscape contractor who specialized in "rockery wall" construction. Contributing to the educational and professional experience of the battalion staff/company teams, the National Guard engineers included four licensed PEs (PE-Civil); one PhD (Materials) and civil engineer (PE-Civil) warrant officer; one EIT; a company commander with a master's in construction management; an Air Force major (executive officer of JTF/Company Team Kansas) who is a licensed PE with the Federal Aviation Administration; and an Air Force major (commander of JTF/Company Team Kansas) who is a licensed architect. A combined 145 years of professional (civilian) engineer and construction management experience was brought to this civil/military problem.

PROJECT PLANNING AND CONTROL

In order to utilize construction assets effectively and to determine a realistic timeframe for project completion, it was immediately apparent that a resource-based critical path analysis (CPM-Project Plan) needed to be completed. With this task in mind, the construction management team conducted a detailed reconnaissance to include critical measurements of each project site. Those measurements were used to determine quantifiable sub-tasks. The damaged sites were initially identified by location on U.S. Hwy 36 as sites 1–17 by the Fires Brigade Mission Command cell (147th BSB). This was unsatisfactory as a way to identify specific locations along the project. Therefore, the road was further tagged with more descriptive traditional station numbers every 100 feet.

Upon inspection of the task list and associated quantities, a critical component of reconstruction efforts emerged: haul capacity. The task force's ability to haul enough fill for significant scouring of the road bed and to develop proper road/slope integration set the pace for the entire project. Consequently, haul assets became the pacing item used to estimate daily progress and to develop a resource-based operational Gantt chart. Because the task force could field approximately 25 dump trucks at any given time, five teams (five trucks each) were figured to cycle through each project site with average capacity and cycle times used in the calculation. Assuming a 10-hour workday made estimating the length of each project (based on hauling, culvert installation, paving, etc.) a matter of simple arithmetic once work rates were determined.

Once a project timeline was established, a "fail-safe" was needed to prepare for the unpredictable. As a result, a "project float" was built into the analysis. The assumption was made that sub-tasks would be executed sequentially rather than in parallel and that all resources would be dedicated to a single site until

◀◀ *GEN Grass visits National Guard engineers repairing Hwy 36 in Colorado, receives a brief from LTC Turley.*

◀ *Massive amounts of earth were moved to repair the road damaged by flooding.*

◀◀ *Flood-damaged home along Hwy 36 between Lyons and Estes Park, CO. Many homes were destroyed or damaged without access to roads or utilities.*

◀◀ *Severe road damage along Hwy 36 due to flooding.*

◀ *Entire communities were stranded between Lyons and Estes Park, CO, over a 25-mile stretch of highway broken in several locations.*

▶▶ *BEFORE photo of the rockery wall in need of repair.*

▶ *National Guard combat engineer soldiers or "Sappers" provided much of the debris-clearing manpower.*

▶ *National Guard soldiers installed 24 culverts during the road-repair mission.*

completion before moving to another location. Prior to the arrival of the 1457th EN BN, the mission called for a "combat trail" by 2 December. The critical path analysis conducted by the construction management team showed completion as early as 31 October with proper sequencing of construction and "project crashing." As the scope of the operation evolved, adjustments were made to the site-specific sub-tasks and the respective Gantt chart. The October prediction for completion proved to be remarkably close. On 4 November, the project was paved and safety features such as speed attenuator barrels and jersey barriers installed, 28 days early.

TECHNICAL CONSIDERATIONS

CULVERT INSTALLATION/ REMEDIATION (10 OF THE 18 SITES)

In many instances, existing culverts along U.S. Hwy 36 were either partially severed or entirely removed by the flood wave and debris flow. Consequently, a critical component of the reconstruction effort consisted of culvert installation or remediation throughout the flood corridor. Culverts were sized based on the diameter of existing structures (where such a determination was possible) or on relative estimates of contributing drainages; however, most installations required nothing larger than a 24-inch corrugated steel pipe (CSP) culvert. In order to facilitate drainage, shallow swales were cut on the up-slope side of the road, terminating in rock-lined catch basins at the inlet of the respective culverts. To ensure proper drainage, Sappers from the 118th EN Co. (SAPPER)/1457th EN BN installed the culverts using bedding sand or ½-inch-minus gravel after establishing vertical control and culvert slope (generally 1% to 2%) using a survey level and rod. Great attention was paid to the minimum cover requirements of each culvert to ensure that they would withstand daily vehicle and construction traffic. Occasionally, the vertical alignment of a respective project site was adjusted to compensate for cover and riparian freeboard constraints (to prevent higher-flows from damaging the outlet of the culvert).

GEOTEXTILE FABRIC APPLICATIONS (8 OF THE 18 SITES)

A heavyweight, non-woven geotextile fabric was utilized in two separate applications throughout the U.S. Hwy 36 reconstruction corridor. In some instances, erosion from the flood waters exposed roadway embankments that were largely composed of silt and fine-grained soils. Prior to armoring the embankment with large-diameter rip-rap, geotextile fabric was applied in overlapping lengths running perpendicular to the flow of the river. In this capacity, the fabric acted as a filter to prevent the escape—or "piping"—of fine-grained material from the soil matrix as a result of wave action or seepage gradients. In a different application, the same geotextile fabric was used to reinforce pavement sections in areas where the roadway exhibited significant instability (i.e., pumping) due to inadequate subgrade material or excess soil moisture due to earlier precipitation events. The fabric was generally applied between the fine-grained subgrade and the coarser-grained gravel or road base in order to aid in bridging the granular matrix and increase the pavement section's shear strength.

STREAM ALTERATION/RIPARIAN REMEDIATION (ALL SITES)

Throughout reconstruction efforts, engineer equipment operators were repeatedly forced to enter the stream channel in order to temporarily divert the flow around structures or away from the embankment as material was being hauled and placed. During the early stages of Operation Sapper Fury, much of the material used to shore up the embankment toe was harvested directly from the large diameter boulders that had been washed down the corridor during the flood event. Fortunately, the ECC had the foresight to file an Emergency Section 404 Permit through the U.S. Army Corps of Engineers (USACE) which legally allowed the task force equipment to operate within the stream channel on an "as-needed" basis. Generally speaking, wherever operators were forced to enter the stream channel, concerted effort was made to improve the stream channel and embankments once complete. Some of the remediation involved replacing larger rocks within the channel bed to increase the aeration and the dissolved oxygen (DO) level of the stream for native aquatic organisms. When and where possible, equipment operators attempted to build and armor channel embankments adjacent to civilian homes in order to reduce the threat of continued erosion and wave action degradation.

ROCKERY WALL (SITE 11)

During the deluge, abutments to the bridge connecting County Road 80 to U.S. Hwy 36 were severely scoured and undermined, exposing the undergirding and steel H-piles that supported the concrete super-structure. At the request of CDOT, TF Pioneer was tasked to build a large rockery wall to protect the bridge from future events and daily wave action of the North Saint Vrain River. To avoid unintentional vertical and horizontal slip joints, the task force decided to avoid using the flat-surfaced sandstone—readily available from a nearby quarry—and contracted with a quarry further up the mountain to provide large, angular granite boulders. Through careful and meaningful placement, the angular rock was positioned to provide enhanced interlock in order to resist the soil creep forces associated with the repeating freeze-thaw cycles of the region. Fortunately, an airman from the 219th RED HORSE Squadron out of the Montana Air National Guard worked as a civilian landscaper and could place the boulders expertly. However, rockery walls are generally not recommended to be used as retaining structures

beyond a few feet in height unless they are mechanically reinforced or stabilized. Consequently, approximately 100 cubic yards of Controlled Low-Strength Material (CLSM or flowable fill) was used to backfill behind the rockery wall at two separate stages in order to reduce the lateral soil pressure on the backside of the structure. Incorporation of the CLSM also served to fill voids in and around the H-piles and beneath the underside of the concrete pile-cap as well as other areas where soil placement and compaction was impossible. Upon completion, the rockery wall stood approximately 20 feet tall at the bridge abutment, tapering down to 5 feet over a span of 110 feet.

COUNTY ROAD 47 BRIDGE BYPASS (SITE 18)

During the flood event, several small-scale dams were breached near the headwaters of the West Fork of the Little Thompson River, resulting in a massive flood wave and debris flow that completely destroyed the County Road 47 river-crossing near the confluence of the West Fork and the Little Thompson Rivers. TF Pioneer was tasked with constructing a hasty bridge-crossing in order to facilitate follow-on repairs on CR 47 by civilian contractors. Approximately 50 homes were in dire need of preparation for the winter and no other points of access were available.

In order to pass the flow of the rivers, ten 8-foot concrete box-culverts were procured from Denver International Airport and transported on Light Equipment Transport (LET) 40-ton trailers to the project site where they were off-loaded by very skilled hydraulic excavator (HYEX) operators. Prior to placing the large box culverts, the river crossing was surveyed and staked out by the construction management team in order to preserve the existing road alignment to the greatest extent possible. The confluence of the two rivers was then diverted to the far side of the project site via coffer dam in order to allow the operators to prepare the culvert bedding from the near side. Following the diversion of the rivers, a 20′ x 40′ footprint was excavated to match the existing flowline elevation of the natural stream bed. A heavy-duty non-woven geotextile fabric was then applied atop the subgrade prior to applying, compacting, and leveling a 12″ layer of 1½″ gravel bedding. The geotextile helped the gravel bedding to bridge the native subgrade and prevent penetration and/or mixing.

Once the bedding was leveled and compacted, the box culverts were emplaced using a HYEX. A survey level was used to check the level of the culverts throughout placement. Once in place, engineers used non-shrink grout to seal the joints of the double-barreled culverts before backfilling around them. The approach, inlet, and outlet apron were extensively armored with the same geotextile and large-diameter boulders to prevent scour around and beneath the structure. Once the culverts were adequately armored, the confluence was re-diverted through the culverts, allowing the engineer equipment to work on the far side of the alignment. The remnants of the existing road alignment were used to ramp over the culvert and graded to make a gradual transition across the river, capable of being trafficable by the civilian wheeled vehicles that the contractors would use during their construction efforts.

SUMMARY

On 4 November, U.S. Hwy 36 re-opened during a press conference and ribbon-cutting ceremony with Colorado governor John Hickenlooper. The road had been opened 28 days ahead of the most optimistic CDOT estimates. The leadership of TF Pioneer and CDOT participated with local civic leaders in ceremoniously driving the first civilian/pilot vehicles through the checkpoint and dismantling the traffic control points at the entrance to the canyon. The mayors of Longmont, Lyons, Pinewood Springs, and Estes Park, CO, joined the state governor in expressing their appreciation for the National Guard effort in their communities. TF Pioneer had returned to public service U.S. Hwy 36, a winding and mountainous (8,200′ at its highest elevation) 25-mile section of Colorado highway. The TF had commanded 378 soldiers and airmen from four states during a federal government shutdown. They had moved 44 pieces of engineer equipment over 500 miles from Utah to Colorado with a 5-day warning order. When the dust settled, TF Pioneer had managed a total of 77 pieces of engineer equipment including Colorado Army National Guard and civilian contracted equipment; hauled 34,200 cubic yards (CY) of material; emplaced 12,690 CY of native material including 60 CY of boulders for armor and retaining structures; poured more than 100 CY of flowable fill; placed more than 120 yards of geotextile fabric; removed more than 1,155 feet of damaged guard rail; and placed 21 culverts. Though unconventional doctrinally and educationally, the five professional civil engineers and the one Ph.D.-level PE brought more than 145 years of professional experience to the problem and is typical of many Army National Guard engineer battalions with diverse civilian-acquired skills. These additional skills enabled the task force to design and build at a rapid pace, exceeding the standards of CDOT and ahead of schedule.

Celebrated as a rare governmental success story during that period, the effort and the success of this project did not come without lessons learned. This type of joint-service, inter-agency, civil response required an intense level of interaction between agencies and state National Guards. Liaison between state Domestic Operations (DOMOPS) coordination cells and the NGB Domestic All-Hazards Response Team (DART) facilitated the use of state active-duty funds early in the process and led to mission

The flooded river complicated efforts to repair Hwy 36.

Expert operators moved box culverts into position side by side after diverting the river.

CW2 Don Summit, PhD, PE, provides some helping hands to move a box culvert into position.

AFTER photo of the rockery wall designed by National Guard Engineers and constructed with the help of the 219th RED HORSE Squadron from Wyoming.

▶ *Soldiers prepare to load their gear for the month-long state active-duty mission to Colorado.*

▶ *Geotextile material was used as a filter to prevent the escape of fine-grained material from the soil.*

▼ *Mission command was managed by the staff of Headquarters Co., 1457th EN BN, Utah Army National Guard. Special staff included a construction management cell with licensed engineers and a public affairs officer from the Kansas Air National Guard.*

success. Improvement could be made by conducting a formalized pre-emergency drill/rehearsal of the EMAC process to include governors' staffs, the state National Guard DOMOPS, and regional DART teams. This would expedite response times and minimize funding and authority confusion in the early stages of future operations. Once organized, federal and/or state funding of orders for soldiers and airmen could then be arranged via assigned mission command/task organizations and refined as part of the initial troop movement.

Another lesson learned includes the rehearsal and planning of State joint force headquarters (JFHQs) where Army and Air National Guard engineer forces could organize into unified command structures much like the National Response Framework (NRF).

"Joint Task Force Kansas" was an example of this type of pre-planned, combined joint task force/team that gave the governor of Kansas and TAG Kansas significant flexibility in responding with Army and Air Force units.

This tailored force was able to integrate into TF Pioneer/JTF Centennial rapidly and to assist the governor of Colorado with the forces available at the time and still meet the personnel and expertise requirements of the mission.

This is a lesson for JFHQs across the nation. States should consider organizing combined joint task forces and train to implement integration procedures (such as Colorado's outstanding JRSOI process) on a regular basis for similar civil emergency scenarios.

The incorporation of the ARSST 28, Company 217, 117th Space Support Battalion, into the ECC was invaluable. Their ability to create real-time imagery (maps and topographic planning documents) into the planning and execution cycles reduced recon trips, allowed for critical measurements of project sites as work continued, and allowed for a more developed situational awareness for MEDEVAC planning and equipment staging in the narrow canyon. Though not a typical Army engineer batallion MTOE component, "Space Soldiers" bring a powerful resource to the engineer commander on the ground.

TF Pioneer operating under JTF Centennial/Colorado National Guard during Operation Sapper Fury was able to accomplish this mission 28 days ahead of schedule in a dynamic and challenging period through excellent state-to-state cooperation, the flexibility of multiple governors and their TAGs, the National Guard's innate multi-service organization, the coordination of multiple civilian state agencies, and the civilian-acquired skills and ingenuity of the citizen soldiers/airmen engineers.

The motto of the Engineers was never more appropriate.

ESSAYONS!

LTC MICHAEL J. TURLEY, *Utah Army National Guard, commands the 1457th EN BN and Commanded Task Force Pioneer during Operation Sapper Fury. He holds a bachelor of science from Chapman University in Orange, CA, and an MBA from the University of Phoenix. He has commanded a Sapper company in Baghdad and an Army National Guard recruiting battalion. He is an Active Guard/Reserve Officer (AGR) and is currently Administrative Officer for the 204th Maneuver Enhancement Brigade at Camp Williams, UT, in addition to commanding the 1457th.*

MAJ DAVID J. GIBB, *Utah Army National Guard, is the 1457th EN BN XO and managed all staff operations during Operation Sapper Fury. He holds a bachelor's from Brigham Young University and a master's from Utah State University. He served as company commander for the 1457th EN BN before fulfilling several staff assignments to include his current position as an AGR Battalion Executive Officer.*

CPT BLAKE BINGHAM *is a commissioned Army engineer officer and licensed PE. He has a professional background in geotechnical and water resources engineering. He graduated from Utah State University in 2003 with a BS in civil engineering and is currently pursuing a master's in civil engineering from Colorado State University (expected 2015). He works as a civil engineer for the Utah Department of Natural Resources.*

CW2 DON SUMMIT *is an engineer warrant officer, MOS 120A. He was commissioned in 1983 and served as an engineer officer on many horizontal and vertical construction projects in many parts of the world. He commanded the 204th MEB as an engineer colonel before reverting to a warrant officer. He has earned BS, MS, and PhD degrees in civil and environmental engineering.*

SSG JECCA GEFFRE *works in the Colorado National Guard Public Affairs Office and is currently the 104th Public Affairs Detachment NCOIC. She deployed as a photojournalist with the Army National Guard to Kosovo and served on state active duty for fire and floods in North Dakota as well as the floods in Colorado. Geffre studied mass communications at University of Maryland European Division.*

PHOTOS PROVIDED BY LTC MICHAEL J. TURLEY, MAJ D.J. GIBB, AND THE UTAH ARMY NATIONAL GUARD PUBLIC AFFAIRS OFFICE; 2LT ANGELA BREES, KANSAS AIR NATIONAL GUARD; AND SSG JECCA GEFFRE, COLORADO NATIONAL GUARD PUBLIC AFFAIRS OFFICE.