Design and Construction of the Paddys Run Streambank Stabilization Project at the Fernald Preserve, Harrison, Ohio - 16165

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ABSTRACT

The Fernald Preserve is a former uranium-processing plant that underwent extensive remediation pursuant to CERCLA and is now managed by the US DOE Office of Legacy Management. While remediation of buildings and soil contamination was completed in 2006, aquifer remediation is ongoing.

Paddys Run is a second-order stream that runs to the south along the western side of the Fernald Preserve. The Paddys Run watershed encompasses nearly 41 km^2 (16 mi^2), including most of the Fernald site. Field personnel conducting routine site inspections in March 2014 observed that Paddys Run was migrating east via bank erosion into the “Pit 3 Swale,” an area of known surface-water contamination. The soil there was certified pursuant to site regulatory agreements and meets all final remediation levels. However, weekly surface-water monitoring is conducted from two puddles within the swale area, when water that exceeds the final remediation levels is present. Paddys Run had migrated east approximately 4 m (13 ft) in 2 years and was approximately 29 m (95 ft) from the sample location. This rapid migration threatened existing conditions that allowed for continued monitoring of the swale area and also threatened Paddys Run water quality. Therefore, DOE and regulators determined that the east bank of Paddys Run required stabilization. This was accomplished with a design that included the following components: relocation of approximately 145 m (475 ft) of streambed 9 m (30 ft) west, installation of a rock toe along the east bank, installation of two cross-vane in-stream grade-control structures, stabilization of a portion of the east bank using soil encapsulated lifts, and regrading, seeding, and planting within remaining disturbed areas.

In an effort to take advantage of low-flow conditions in Paddys Run, construction was initiated in September 2014. Weather delays and subsurface flow within the Paddys Run streambed resulted in an interim shutdown of the project area in December 2014. Construction activities resumed in April 2015, with completion in November 2015.

To date, this stabilization project has been successful. The regraded bank and streambed have remained stable, and no compromise to installed cross-vanes, the rock toe, or the soil encapsulated lifts has been observed.

INTRODUCTION

The Fernald Preserve is situated on a 425 ha (1,050 acres) tract of land, approximately 29 km (18 mi) northwest of Cincinnati, Ohio. The site is located near the unincorporated communities of Ross, Fernald, Shandon, and New Haven in

Hamilton and Butler Counties, Ohio (Fig. 1). It is a former uranium-processing facility that was shut down in 1991. Since then, the site has undergone extensive remediation pursuant to CERCLA. Remedial activities and subsequent ecological restoration has converted the site from an industrial production facility to an undeveloped park, encompassing wetlands, prairies, and forest. Upon completion of large-scale soil remediation and waste disposition in the fall of 2006, the site was successfully transitioned to the US DOE Office of Legacy Management. While remediation of buildings and soil contamination was completed in 2006, aquifer remediation is ongoing. Portions of the site are open to the public, with approximately 11 km (7 mi) of walking trails that are open year-round and a visitors center that is open Wednesdays through Saturdays. The current configuration of the Fernald Preserve is shown on Fig. 2.

Background

Surface-water sampling by Ohio EPA in late 2006 indicated that total uranium concentrations were elevated above the site final remediation level at several locations. DOE confirmed the results within a depressional area west of the former Waste Pits. The area of concern is a 1.3 ha (3.2 acres) floodplain located between Paddys Run and the former Waste Pits area known as the “Pit 3 Swale” (Fig. 3). The specific locations of elevated surface water are actually puddles that are dry for portions of the year. Soil in the swale area was certified pursuant to site regulatory agreements and meets all final remediation levels, so the cause of the elevated surface-water concentrations was uncertain. DOE investigated the issue in 2007 and concluded that the issue was likely due to variability in the leachability of uranium. This issue is detailed in the 2011 CERCLA Five Year Review for the site [1].

The puddles do not drain into Paddys Run during normal flow conditions. Groundwater underlying the swale area is also contained within the capture zone for an onsite extraction well. Furthermore, the swale is not located near a publicly accessible area. For these reasons, regulators agreed to have DOE continue weekly monitoring of the puddles, with the expectation that surface-water concentrations would fall over time. Results of weekly sampling are presented annually in the Fernald Preserve Site Environmental Report [2].

Paddys Run is a second-order stream that runs to the south along the western side of the Fernald Preserve. It is approximately 14.5 km (9 mi) long and flows into the Great Miami River about 2.4 km (1.5 mi) downstream of the site. The Paddys Run watershed encompasses nearly 41 km^2 (16 mi^2), including most of the Fernald site. For most of the on-property reach, Paddys Run has eroded through the clay-rich glacial overburden into the underlying sand and gravel comprising the Great Miami Aquifer. This results in the stream being intermittent in nature from June through October.

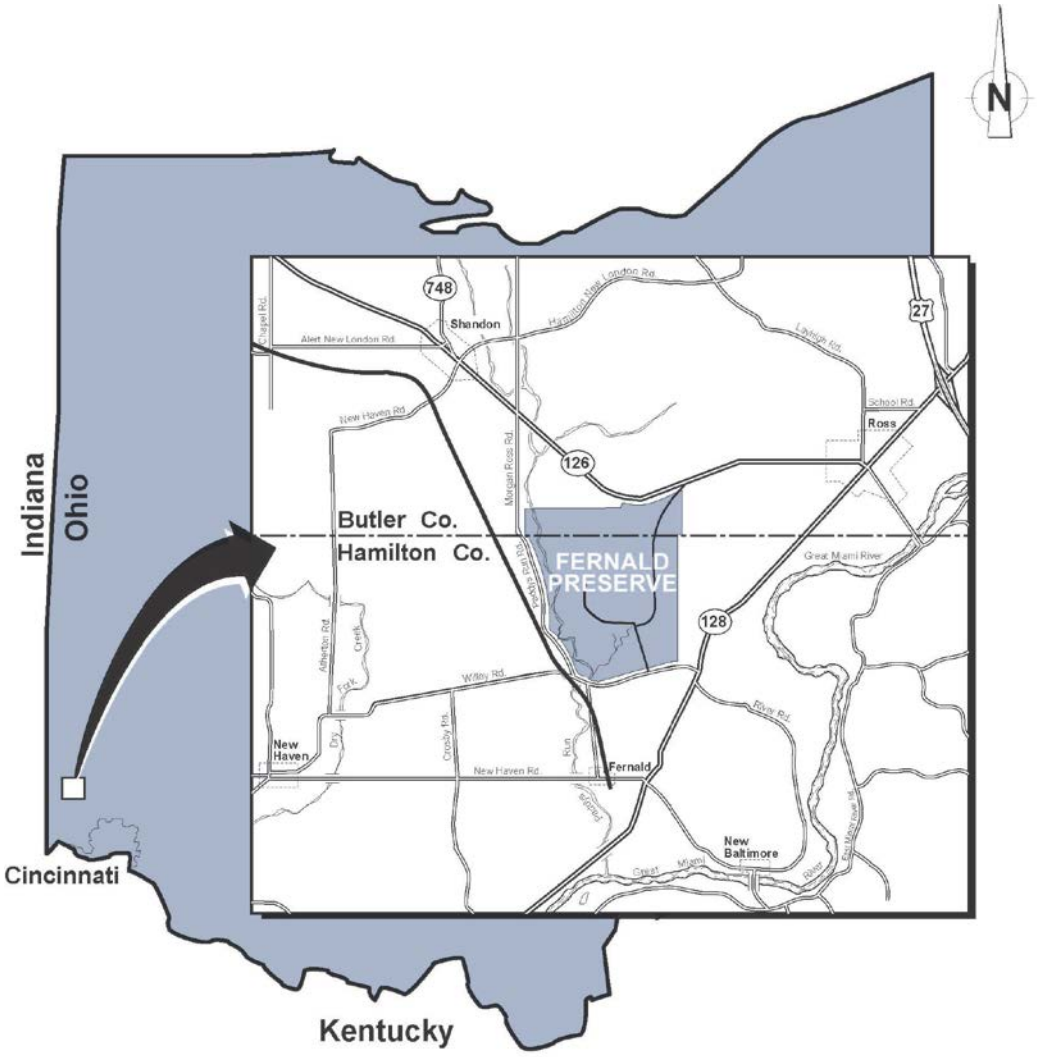

Fig. 1. Fernald Preserve, located in Hamilton and Butler Counties, Ohio

Personnel conducting routine site inspections observed that Paddys Run was migrating east via bank erosion into the Pit 3 Swale area, specifically Sample Location SWD-09 (Fig. 4). Paddys Run had migrated east approximately 4 m (13 ft) in 2 years and was approximately 29 m (95 ft) from the sample location. The recent erosion also resulted in a reduction of the bank height by approximately 1 m (3 ft), thereby reducing the freeboard elevation above Sample Location SWD-09 (Fig. 5). This rapid migration threatened the current conditions that allowed for continued monitoring of the swale area. Additionally, there was concern that continued erosion would result in the contamination of Paddys Run. Therefore, DOE and regulators determined that the east bank of Paddys Run required stabilization.

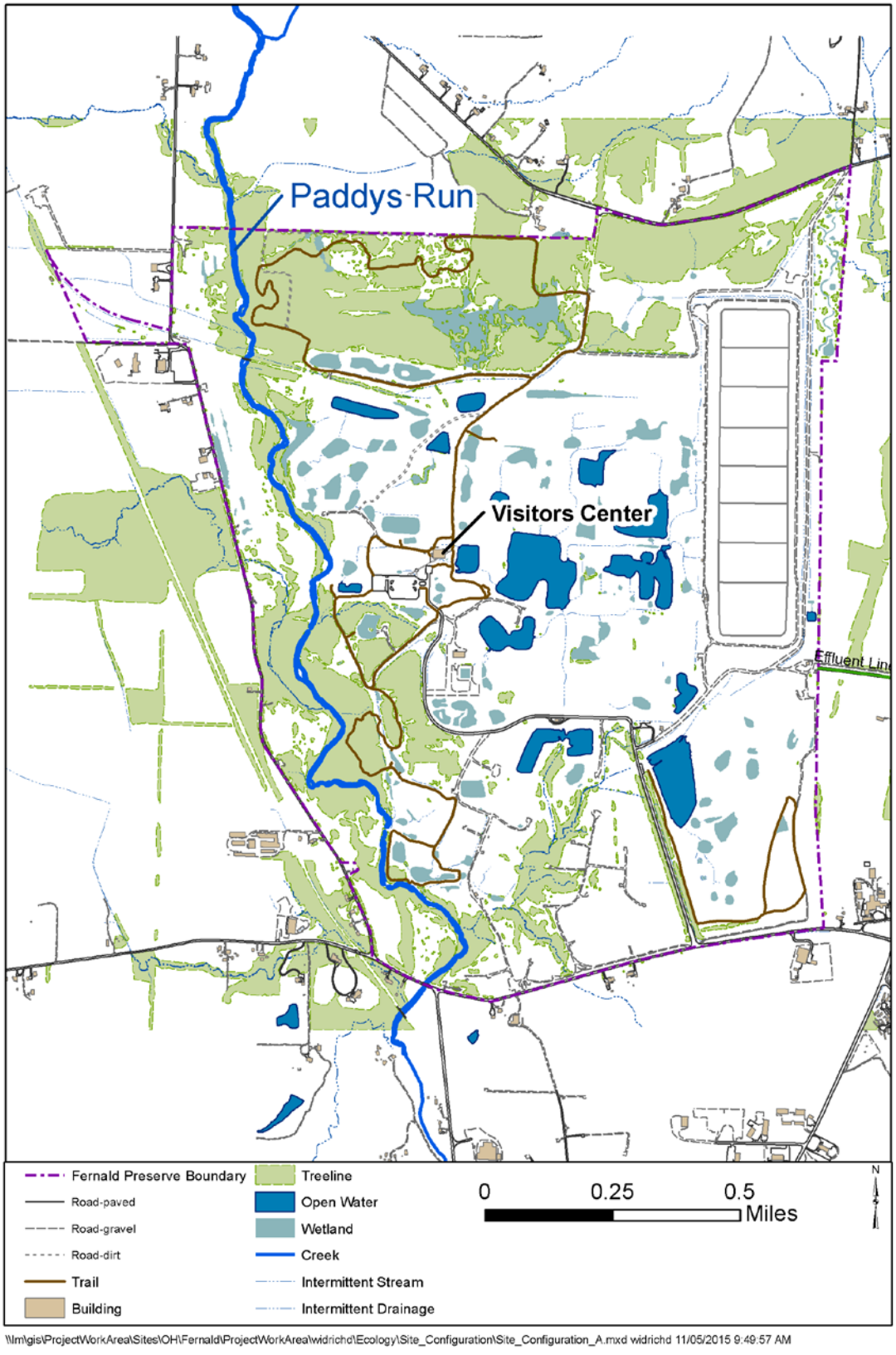

Fig. 2. Fernald Preserve site map

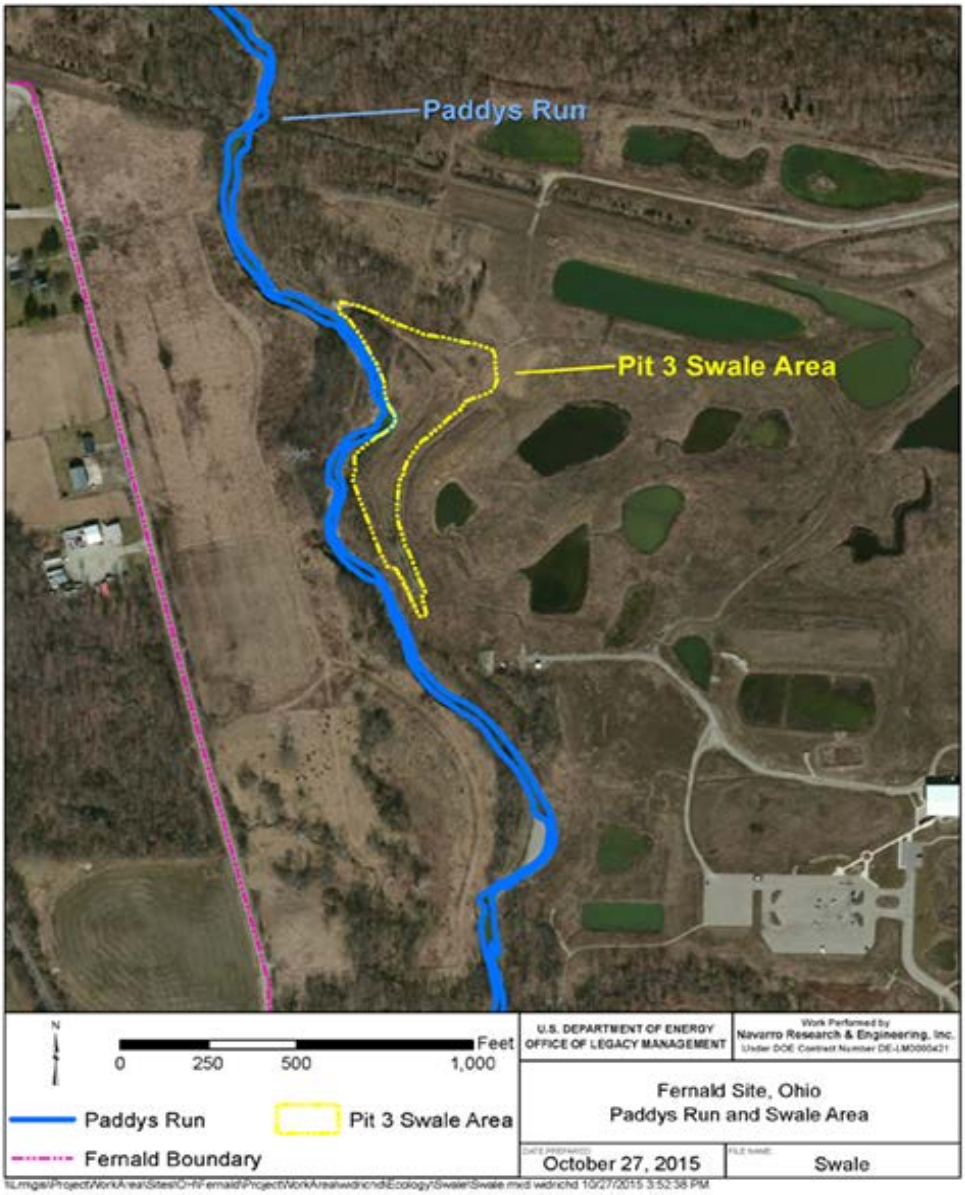

Fig. 3. Pit 3 Swale area located between Paddys Run and the former Waste Pits

IMPLEMENTATION STRATEGY

The intermittent nature of Paddys Run yields ideal conditions for conducting in-stream grading and construction activities during the late summer, when on-property flow is greatly reduced or nonexistent. In addition, there was concern that one significant storm event could result in stream exposure to Sample Location SWD-09. Therefore, the consensus was to expedite design and commence field implementation in September 2014.

A subcontract design-bid-build strategy was determined as the preferred approach to accomplish the expedited schedule. From a regulatory perspective, the work was considered a response to an "unacceptable condition" pursuant to the *Fernald Preserve Legacy Management and Institutional Controls Plan* [3]. Ongoing communication with regulators and the Fernald Natural Resource Trustees allowed for a collaborative approach to implementation, with expedited parallel reviews and stakeholder communication.

Design goals and objectives were developed that included the following:

Goal 1: Prevent lateral migration of Paddys Run into the "Pit 3 Swale"
- Objective 1A: Provide protection for a 25-year, 24-hour storm event
- Objective 1B: Maintain current top of bank elevations within the project area

Goal 2: Protect and expand existing forest communities upstream and downstream of the project area
- Objective 2A: Maintain to the extent possible, current forested area on the east bank
- Objective 2B: Establish forested buffer that connects upstream and downstream forested communities

Goal 3: Minimize in-stream impacts upstream and downstream of the project area
- Objective 3A: Use grade control structures as necessary to maintain existing streambed elevation

The above goals and objectives were developed to ensure that the design would be effective both near term and long term. They also aim to minimize upstream and downstream impacts to Paddys Run.

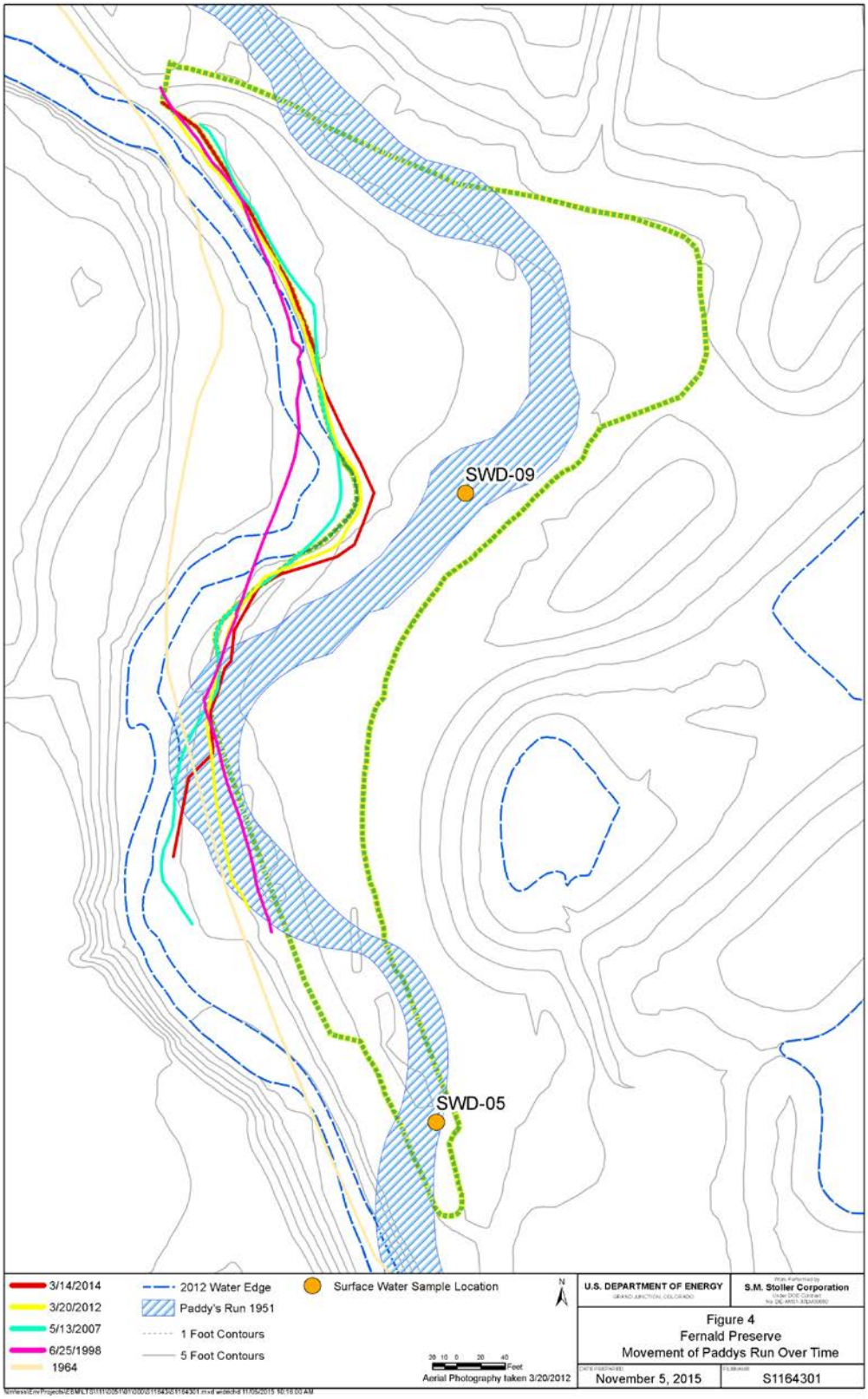

Fig. 4. Paddys Run steam migration over time, with the Pit 3 Swale area outlined in green striped line

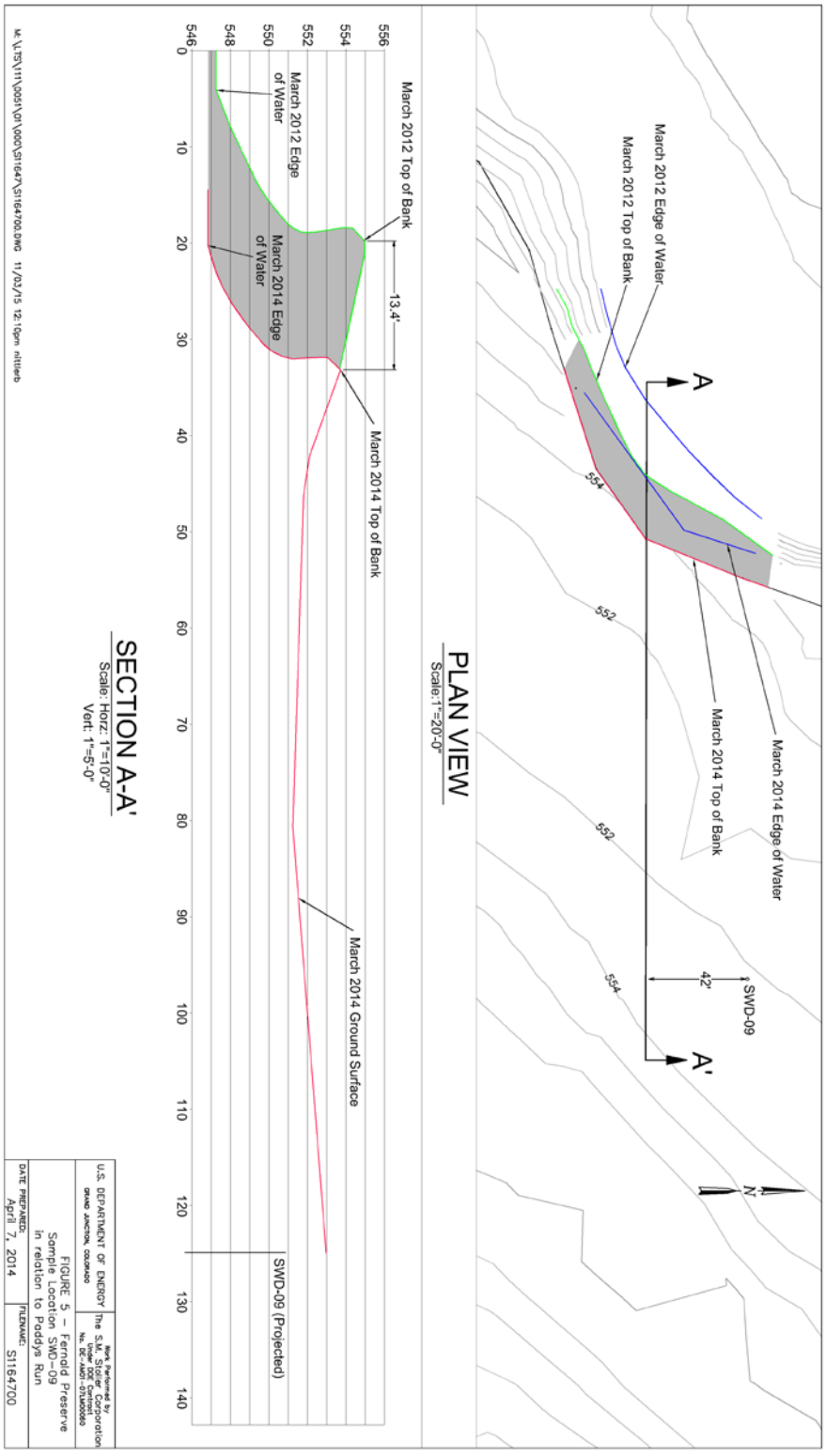

Fig. 5. Paddys Run erosion results in a loss of bank elevation

Apex Companies LLC was awarded the design subcontract in June 2014 following a competitive bid. An aggressive design schedule was implemented to ensure field implementation in September 2014. The first step in the design process was to present stakeholders with several alternatives to meeting the goals and objectives outlined above. The design subcontractor developed an alternatives analysis that presented five different options for bank stabilization:

- Retaining wall
- Limestone riprap
- Soil encapsulated lifts
- Log/rootwad revetment
- Regrade, fabric and plant

These options represented a range of approaches from traditional hard armoring to bioengineering control. Each option was evaluated against cost, constructability, durability, risk, and probability of successfully meeting project goals and objectives. Regulators and other stakeholders were afforded an opportunity to review and comment on the alternatives analysis, and a consensus approach was reached to use a combination of riprap, soil encapsulated lifts, and regrade, fabric and plant (Fig. 6).

Design

The final design included the following components: temporary relocation of approximately 145 m (475 ft) of streambed 9 m (30 ft) west, installation of a rock toe along the east bank, installation of two cross-vane in-stream grade control structures, stabilization of a portion of the east bank using soil encapsulated lifts, and regrading, seeding, and planting within remaining disturbed areas.

Apex Companies initiated design activities by conducting a field walkdown and data collection to characterize local stream hydrologic, hydraulic, and geomorphic conditions. Field personnel delineated site constraints, measured channel dimensions, determined bankfull discharge, conducted a survey to delineate channel planform and longitudinal profile, conducted a channel substrate analysis, and assigned an “F5” Rosgen stream classification [4]. F5 streams are entrenched, with active bank erosion and high sediment loads. The design intent was to convert the Paddys Run reach in the area of concern to a more stable “C3” channel type, which involves riffle/pool morphology and meandering channel within a well-developed floodplain. This type of stream is common in southwest Ohio when disturbance is minimal [5]. The entrenched conditions in Paddys Run required that some sort of hard armoring be installed in order to adequately stabilize the bank.

Compliance issues included the need to meet substantive requirements of a Clean Water Act Section 404 permit (i.e., Nationwide Permit No. 38) and several measures to avoid impacts to threatened and endangered species. A bat emergence survey was conducted to determine whether federally endangered Indiana bat (*Myotis sodalis*) or northern long-eared bat (*Myotis septentrionali*s) species were present. The project area encompasses summer breeding habitat for these species.

While no bats were observed, DOE committed to minimize tree loss and to avoid any vegetation removal until after October 1. Sloan's crayfish (*Orconectes sloanii*) is a state-threatened species that inhabits the project area. Areas that would be disturbed by construction activities were seined on several occasions, in an effort to relocate Sloan's crayfish and native fish species upstream of the project area. Relocation was identified as the proper course of action in the *Integrated Environmental Monitoring Plan*, which is an attachment to the *Fernald Preserve Legacy Management and Institutional Controls Plan* [3].

Construction

Construction activities commenced in September 2014, following an open-bid procurement. Water Quality Systems, Inc. was awarded a fixed-price contract for this work, with a planned completion in December 2014. Field activities were initiated with ideal conditions in Paddys Run. No flow was present in the stream, with water ponded in several deep pools within the project reach.

Field preparation activities included limited clearing and grubbing, establishment of access corridors, and installation of a cofferdam and diversion channel that diverted stream flow. The cofferdam proved very helpful as flow conditions returned to Paddys Run following significant rainfall in mid-October 2014. The cofferdam allowed for continued in-stream work that included channel relocation, installation of the rock toe, and construction of the upstream cross-vane. These two stone features provided sufficient interim bank protection until the remaining portions of the project could be completed.

One unanticipated condition that required additional work was subsurface flow in Paddys Run. The cofferdam was successful in diverting surface water, but perched water presented challenges that slowed work. Approximately 1,300 m^3 (1,700 yd^3) of limestone class "B" riprap (30–46 cm [12–18 inch] diameter) was needed to install the rock toe along the length of the project area. Field personnel had to place an extra 380 m^3 (500 y^3) of stone due to the perched water that prevented adequate compaction at the base of the rock toe.

Cross-vane installation consisted of limestone boulders stacked 2 m (6 ft) deep and 1 m (3 ft) wide across the streambed, with arms that extend on either side of the bank. Typical construction of this type of feature is shown in Fig. 7. Boulders needed to be handled one at a time due to their size and associated difficulty in placement.

By the time the rock toe and the upstream cross-vane installations were completed in late November, weather conditions had deteriorated to the point that it would not be possible to complete the project. The decision was made to place the project in a stable configuration and resume construction activities in spring 2015. Because of the intermittent nature of Paddys Run, remaining work was conducted in two phases. Work resumed in April 2015, with the installation of dormant willow posts into the rock toe, construction of the soil encapsulated lifts, and tree and shrub planting. The downstream cross-vane and remaining section of rock toe work was

scheduled for August 2015. However, above-average rainfall through most of the summer resulted in the need to delay cross-vane installation to October 2015. Conditions were again ideal for in-stream work, and the downstream cross-vane and rock toe were completed successfully. Final grading and planting activities were completed in November 2015.

Fig. 6. Concept Plan for the Paddys Run Streambank Stabilization Project [Figure prepared for DOE by Apex Companies, LLC, (5)]

RESULTS

Performance to this point has been very good. The regraded bank held stable following several high-flow events since January 2015, with Paddys Run stream levels rising approximately 0.6 m (2 ft) above the rock toe. No compromise to installed cross-vanes, the rock toe, or the soil encapsulated lifts has been observed. The only issue observed to date is that of woody plant survival. The design called for 1,350 container-grown plants to be installed across the project area, including the regraded bank. Plant material was delivered in fall 2014, but not installed until the following spring due to the winter shutdown. This is the likely cause of significant mortality at the end of the first growing season. Plant survival was calculated in August 2015 at approximately 26%. However, large-scale replanting was not needed. A number of volunteer woody seedlings have been observed

across the regraded bank. It is anticipated that vegetation establishment on the bank will be adequate, once volunteer cottonwood (*Populus deltoides*) and American sycamore (*Platanus americanus*) seedlings become established. Limited planting was conducted in the remaining disturbed areas following installation of the downstream cross-vane.

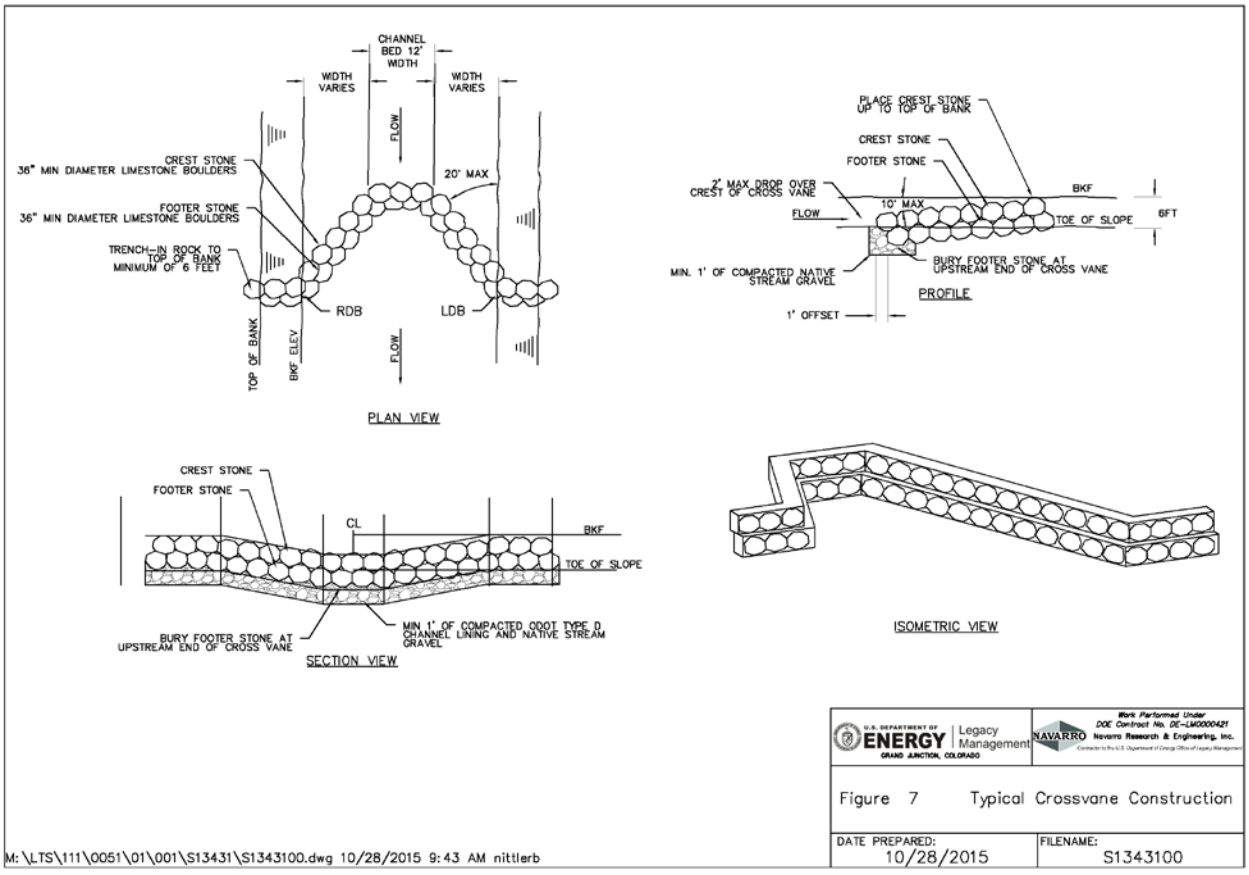

Fig. 7. Typical cross-vane construction at Paddys Run project [6]

CONCLUSION

The rapid stream bank migration of Paddys Run at the US DOE Fernald Preserve site threatened the ability to monitor a nearby swale area for contamination. Additionally, there was concern that continued erosion would result in the contamination of Paddys Run. In response, DOE and regulators implemented a stream bank stabilization plan. Performance to this point has been very good. The regraded bank and stabilized streambed have been stable following several high-flow events since January 2015, with Paddys Run stream levels rising approximately 0.6 m above the rock toe on occasion. No compromise to installed cross-vanes, the rock toe, or the soil encapsulated lifts has been observed. In summary, the Paddys Run Streambank Stabilization project is an excellent example of DOE moving quickly to address an unacceptable condition at a Legacy Management site. Ongoing communication with regulators and stakeholders was critical in the successful completion of this effort.

REFERENCES

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