Mitigation Narrative

PPL Bell Bend Nuclear Power Plant
Salem Township, Luzerne County, PA

1. Introduction and Purpose

Throughout the site selection and planning phase for the BBNPP project, steps were taken to avoid and minimize environmental impacts. The purpose of this section is to describe the unavoidable remaining impacts and the proposed mitigation projects to fulfill agency compensatory mitigation requirements.

2. Summary of Unavoidable Impacts

Since the initiation of the planning and design of BBNPP, PPL has advanced numerous iterations of the layout and design of BBNPP with the goal of avoiding wetland and stream features. Initial BBNPP layouts included possible impacts to wetlands and streams totaling over 100 ac. In subsequent design iterations direct impacts were reduced to approximately 60 ac in 2008 and then to approximately 30 ac in 2009. In late 2009, a decision was made to move BBNPP substantially north (approximately 900 feet) to an area with fewer wetlands. This major design change resulted in a site footprint with less than 10 ac of total wetland impact. The evolution of the site layout to avoid and minimize wetland and stream impacts is shown and discussed in detail in Section Q of this JPA.

While wetland impacts were substantially reduced, they could not be avoided entirely due to topography and siting requirements of plant components. Following the major shift in the project location additional adjustments were then made to decrease the size of the required temporary and permanent facilities, and to maximize the amount of undisturbed vegetation. These additional efforts resulted in the reduction of permanent impacts from approximately 10 ac to less than 2 ac of permanent impacts requiring mitigation, the majority of which is associated with the cooling water intake system (CWIS).

The following summarizes the remaining wetland and stream impacts anticipated as a result of construction of BBNPP. Both impacts and mitigation are evaluated both quantitatively (disturbed and compensated acreage and stream length) and qualitatively (lost and gained functions and values). Each impact is identified by a letter and each wetland is identified by a number. Wetland and Watercourse Impact Tables, included in the Environmental Assessment, Section J, Part 2, Enclosures D3 and D4, provide a breakdown of acreages associated with each impact. Each impact letter and wetland identification number can be located on the "Wetland and Watercourse Impact Location Map" also provided in the Environmental Assessment (Enclosures D1 and D2). Impacts to wetlands and streams resulting from the BBNPP have been categorized as permanent, temporary, and indirect. Each impact is described in detail in the Environmental Assessment (Section J, Enclosure D). A summary of impacts is provided below.

2.1 Permanent Wetland and Stream Impacts

Permanent impacts are characterized by the placement of fill or grading in a wetland or any structure or activity which changes, expands or diminishes the course, current or cross section of a watercourse, floodway or body of water (obstructions or encroachments).

Permanent wetland impacts resulting from the BBNPP are primarily caused by bridge and utility crossings as well as fill placement to construct and grade around plant infrastructure. Differences between Pennsylvania Department of Environmental Protection (DEP) permanent wetland impact acreage and the United States Army Corp of Engineers (ACOE) permanent wetland impact acreage include isolated wetland impacts and bridge spans. Isolated wetlands do not fall under ACOE jurisdiction, but are regulated by DEP. Bridge spans over wetlands and streams are considered permanent impacts by DEP however ACOE only considers the pier footings placed within the wetland a permanent impact.

Seven bridges or crossings resulting in permanent wetland or stream impacts will be constructed over streams and/or wetlands for vehicle use, rail use, or utility crossings (Impacts A, B, C, D, E, F, G). Five of these bridges will permanently impact wetlands. These bridges were designed to minimize wetland impacts. They will span the entire width of the wetland; therefore only the bridge piers will be physically touching the wetlands. The only crossing resulting in physical alteration of the stream is Impact G, which is a culvert crossing the unnamed tributary to Lake Took-A-While for rail access to the project site. No permanent wetland impacts will result from impact G.

Impacts I, K, and M involve placing fill in wetlands. Impact I requires filling a small isolated wetland (DEP jurisdiction only) to create suitable grading around the power block in accordance with NRC design requirements. Impact M requires placing fill in two small wetlands to expand the existing SSES switchyard. One of these wetlands is isolated (DEP jurisdiction only). Impact K, BBNPP intake structure construction, results in the largest wetland and stream impacts. The proposed intake structure is located on the North Branch Susquehanna River (NBSR) at the existing North Branch Canal (NBC) outfall channel (a manmade channel carrying weir controlled flow from the NBC to the NBSR). This manmade channel and adjacent wetlands will be filled to construct the intake structure. The canal outfall channel will be eliminated, and flow from the NBC that was previously directed to this channel will be re-directed to the downstream reach of the NBC that will be restored as part of the mitigation strategy. The reach of the outfall channel that will not be filled will be converted to wetlands.

2.2 Temporary Wetland and Stream Impacts

Temporary impacts result from disturbances necessary to perform work where the temporarily disturbed area will be restored to its original grade and hydrology. Because temporary impacts will be restored to their original grade, wetland replacement acreage is not required; however, these impacts must still be avoided and minimized to the greatest extent practicable.

Agency differences in temporary impacts are limited to the proposed bridge footprints. DEP identifies these footprints areas as permanent impacts. ACOE temporary impacts for bridge construction will primarily be contained within the shadow of the bridge span and result from excavation and crane pad construction. The routing of underground intake and blowdown lines through wetlands at the Susquehanna Riverlands and the NBC will also cause temporary impacts (Impact M). After installation all temporarily impacted wetlands will be restored to their original grade and will be seeded with a wetland mix.

Construction dewatering (Impact L) will temporarily impact the hydrology of the Tributary 1, Tributary 2 and adjacent wetlands to Walker Run. Construction of the ESWEMS will require dewatering to support completion of construction under dry conditions. This will be a long-term temporary impact (up-to 2 years). A detailed “Construction Dewatering Mitigation Plan,” attached to this narrative, has been developed to mitigate for these impacts.

2.3 Indirect Wetland and Stream Impacts

Indirect impacts result when there is no physical obstruction or encroachment, but changes to vegetation, hydrology, or other factors may alter the functions or values of a wetland. In these cases, the overall wetland location and acreage is not affected, but the lost functions and values must be considered and mitigated. A Functions and Values Assessment was performed to identify the functions and values of all wetlands within the BBNPP project boundary and was used as a basis to determine indirect wetland impacts. Most indirect impacts caused by the construction of the BBNPP are related to habitat changes resulting from tree removal. The "Functions and Values Assessment" is included in Appendix B.

Most of the structures previously discussed which are causing temporary impacts also create indirect impacts resulting from tree removal. The installation of bridges will require the permanent removal of trees to provide clearance for the bridge span and vegetation controls along rights-of-way (Impacts B, C, D, E, and F). The installation of underground intake and blowdown lines will require the permanent removal of trees for security purposes and to maintain the integrity of underground pipelines (Impacts M). Tree removal will minimally affect the wildlife habitat function of the wetlands.

Transmission line construction will only result in indirect impacts (Impacts P, Q, and R). Permanent tree removal will be required to provide clearance for the overhead lines and rights-of-way. Tree removal will affect the wildlife habitat function of the wetlands. The lines will span the entire width of the wetland and therefore no permanent or temporary impacts will result.

2.4 Water Use Impacts

Physical impacts of cooling system water withdrawal from the NBSR could include alteration of site hydrology at, and in areas downstream of, the intake structure. The maximum pumping flow rate from NBSR for BBNPP is expected to be 28,179 gallons per minute (gpm). BBNPP makeup water withdrawal rate during normal operations represents less than 1% of average annual Susquehanna River flow and approximately 5% of the 7Q10 low flow as measured at the USGS Wilkes-Barre Gage. Studies have been completed to determine if BBNPP water use will have a negative effect on aquatic habitat, vulnerable aquatic species, and water quality, especially during drought or low flow conditions. Mitigation of potential aquatic impacts during low flow periods is a requirement of the SRBC and is being separately addressed as part of the Commission's regulatory review.

2.5 Tree Removal Impacts

In addition to deforestation in wetlands, upland forested wildlife habitat will be significantly affected by BBNPP construction. Approximately 234 acres of forest will be cleared, of which approximately 224.5 acres is upland and 9.51 acres is wetland. Tree clearing will cause increased fragmentation of forested habitat. More specifically, tree clearing will impact potential Indiana bat habitat. The Indiana bat is a federally-listed endangered species.

2.6 Impacts to Threatened and Endangered Species and Species of Special Concern

Species that could potentially be impacted by the construction of the BBNPP include the Indiana bat and two mussel species (the Yellow Lampmussel and Green Floater), the Baltimore Checkspot butterfly and the Mulberry Wing butterfly. Tree clearing could decrease available roost tree habit for the Indiana bat. Although suitable habitat exists, the Indiana Bat has not been identified within the Project Boundary. Dredging in the NBSR for intake and blowdown line construction could affect the listed state protected mussel species. The Yellow Lampmussel is widely distributed and will not be affected by the limited area of disturbance needed for intake structure dredging. The green floater is more likely to be found in hydrologically stable streams, not those prone to flooding and drying. While the intake structure will be constructed in a calm pool, the depth and substrate in this area make impacts to Green Floater habitat unlikely. PPL is coordinating with the PA Fish and Boat Commission and will obtain clearance before dredging commences. Impacts to the Baltimore Checkerspot are unlikely because its host plant, turtlehead (*Chelone glabra*) was not found in the wetlands at the BBNPP site. Neither of these butterfly species has been sighted within the BBNPP project boundary.

3. Mitigation Strategy for Permanent and Indirect Impacts

The objective of the proposed mitigation strategy is to provide compensatory mitigation in accordance with the 2008 ACOE Final Compensatory Mitigation Rule. This strategy will fully mitigate for the impacts described above in Sections 2.1 - 2.3 to Waters of the Commonwealth and Waters of the U.S. The mitigation projects will also incorporate measures that address additional habitat impacts as described above in Sections 2.4 - 2.6. All proposed wetland and stream mitigation projects involve an on-site and primarily in-kind permittee-responsible watershed approach. At the time of mitigation planning, there was no wetland banking opportunities or in-lieu fee programs available in Pennsylvania.

Numerous potential mitigation sites were evaluated for compensatory stream and wetland mitigation for the BBNPP project impacts. PPL will implement three of these stream and wetland mitigation projects that were selected based on the mitigation project's ability to satisfy the wetland mitigation acreage needed for the proposed impacts, to replace functions and values affected by the proposed impacts, and to provide the greatest environmental benefits relative to the expected cost of the mitigation measure. The chosen mitigation projects are also intended to address watershed and site specific concerns such as replacement of forested wetland habitat and habitat quality improvements for reproducing brown trout populations in Walker Run. Reports documenting assessments of the existing conditions within Walker Run are included in Appendix B of the JPA. The following projects will be implemented as part of the BBNPP mitigation strategy for impacts to jurisdictional waters:

1. Complete a stream and floodplain restoration project on two reaches of Walker Run creating and enhancing wetlands and wild trout habitat as well as mitigating for permanent stream impacts.
2. Remove a section of Confers Lane, which is to be abandoned, creating additional wetlands and restoring a hydrologic connection between two EV wetlands.
3. Restore the North Branch Canal, enhance wetlands at the PPL Riverlands near the proposed intake structure, and extend the existing recreational trail system.

These projects were designed to work within the context of the site to re-establish ecological connections and restore historic hydrologic conditions. This design approach provides stable, longer lasting results and multiple self-sustaining environmental benefits. All enhanced and created wetlands resulting from these mitigation projects will be in-kind except for the small amount of emergent wetland impacts which will be mitigated with the creation of PFO. The prioritization and establishment of PFO wetlands has been identified by review agencies as an important aspect of mitigation projects on this site. The projects are summarized below. Detailed project descriptions including existing site conditions, design objectives, and methodology can be found in the attached Design Reports and plan sets.

3.1 Walker Run Stream and Floodplain Restoration

The Walker Run mitigation project has been the centerpiece of the mitigation strategy from early in the planning process. This proposed project will use natural stream channel design techniques to improve channel stability, water quality, and aquatic habitat along Walker Run and to restore the functionality of the floodplain.

Two separate segments of stream channel will be restored:

1) Site A – beginning at the Beach Grove Road bridge and ending at the upper North Market Street bridge; and

2) Site B – beginning at the upper North Market Street bridge and ending at the confluence with the Tributary 1 to Walker Run.

The existing habitat within these reaches scored marginal using EPA rapid bioassessment protocols, and poor when using a separate substrate composition and analysis survey (high substrate embeddedness, low gravel and cobble substrate composition). The proposed project will greatly improve Walker Run's habitat, especially for reproducing brown trout populations. Sedimentation and stream bank erosion will also be reduced, improving availability of trout spawning substrate. Varying in-stream conditions including riffles, runs, and pools, as well as fish habitat structures will be established, and eventually a mature PFO wetland will exist along the length of the restored reach improving canopy cover and reducing stream temperatures.

The Walker Run stream and floodplain restoration will account for all of the required wetland mitigation for the BBNPP impacts. The project will create 7.87 ac of wetlands and enhance an additional 5.5 ac through invasive species removal and the planting of native herbaceous vegetation, shrubs, and trees. The project will also re-establish the connection between Walker Run and its floodplain to improve hydrology.

The planting plan for this project was designed with the goal of eventually establishing mature Palustrine Forested (PFO) wetlands to mitigate for losses to forested wetland habitat, including Indiana bat habitat, resulting from permanent and indirect impacts. The functions provided by these wetlands will exceed the functions lost by BBNPP project impacts and will include; enhanced fish habitat, stream stabilization, groundwater recharge, sediment reduction, floodflow alteration, and water quality improvements.

The Walker Run mitigation project will also account for all of the required stream mitigation for BBNPP impacts. The existing straightened and channelized stream will be realigned, creating and enhancing a total of 2,213 LF of channel. Stream channel is created where the existing channel is moved and lengthened. A total of 1,360 LF of created stream channel and 853 LF of enhanced channel will result from the Walker Run mitigation project. Stream enhancements occur where the stream remains in its existing location but channel improvements are made such as bank grading or planting native vegetation.

The implementation of the Walker Run mitigation project will cause permanent wetland and stream impacts; however, these impacts are small compared to the overall benefit. The wetland impacts result at locations where the proposed stream channel has displaced existing wetlands. Stream impacts occur where the existing channel is abandoned. The net mitigation totals created by the Walker Run mitigation project will replace impacted wetland acreages and stream lengths resulting from BBNPP.

3.2 Riverlands – North Branch Canal Restoration

The Riverlands Mitigation Project is two-fold. First, the NBC will be reconnected in its historical alignment. Second, 1.24 acres of wetlands will be enhanced near the proposed intake structure.

The reconnection of the NBC has been identified as the preferred solution to address the proposed filling of the existing manmade NBC outfall channel in conjunction with the intake structure construction. The NBC outfall channel was installed to provide an outfall to the canal weir which is intended to maintain water surface elevation in the canal. The reconnection also includes plans for a walking trail along the old tow path for the length of the restored canal. The reconnection of the canal will mitigate for the wetland values lost from Impact K such as recreation, educational opportunities, uniqueness, and visual quality.

This project will also enhance 1.24 acres of wetlands near the proposed intake structure. The planned enhancement will include removing invasive species and planting native herbaceous species, shrubs, and trees to compensate for reduced PFO habitat.

3.3 Confers Lane Removal/ Wetland Creation

Existing wetlands on either side of Confers Lane are hydrologically similar and were likely connected prior to road construction. The abandonment of Confers Lane presents an opportunity to remove the road bed, re-establish a connection between existing EV wetlands, and create 0.36 ac of additional forested wetland habitat. This small area will be enhanced with native herbaceous plants, shrubs and trees to restore the PFO wetland post construction.

3.4 Summary of Mitigation for Permanent Impacts

A summary table of the wetland and stream mitigation resulting from all three proposed projects is provided below. All created and enhanced wetlands will be planted with trees to replace impacted PFO habitat.

Table 1. Total Mitigation

	Wetlands Enhanced (ac)	Wetlands Created (ac)	Net Stream Channel Created (LF))	Stream Channel Enhanced (LF)
Walker Run	5.52	7.87	1360 ft	853
Riverlands	1.24	0	0	0
Confers Lane	0.04	0.36	0	0
Total	6.80	8.23	1360 ft	853

3.5 Performance Standards

Important components of each mitigation project including created wetlands, enhanced wetlands, stream channel stability and riparian corridor habitat will be evaluated to determine if the following performance standards are achieved.

1. Created and enhanced wetlands will meet the criteria of a wetland by exhibiting appropriated hydrology, soils, and vegetation as specified in the ACOE North Central and Northeast Regional Supplement.

2. Created and enhanced wetlands will support a dominance of native wetland vegetation.

3. Tree survival rate within the created and enhanced wetlands will be 70% or greater.

4. Walker Run will maintain a stable geometry post-restoration and the improved in-stream habitat will support a reproducing brown trout population.

3.6 Monitoring Plan

All monitoring activities will be in compliance with permit conditions. Each mitigation project site will be monitored on an annual basis. Monitoring will include documentation of created and enhanced wetland hydrology, soil profile, and vegetation on a "Wetland Determination Data Form" included in the Northcentral and Northeast Regional Supplement. These wetland monitoring locations, once established, will remain the same for the length of the monitoring. Monumented photograph locations will also be established at each of the project sites to document wetland and stream channel conditions. The presence and location of any invasive species will be noted and appropriate control measures taken. Stream geometry and stability at the Walker Run mitigation site will be documented through the yearly survey of monumented cross sections that can be compared to the as-built survey. Any stability issues will be promptly corrected. In addition, benthic macroinvertebrate and fish assessments will be performed. These monitoring activities are identified in the Walker Run Trout Enhancement Plan (LandStudies, 2010) provided in Appendix B of the JPA.

3.7 Maintenance Plan

The Applicant will maintain the mitigation sites to encourage the growth of native wetland vegetation, control invasive species, and promote tree survival. Periodic mowing and herbicide applications will be utilized during the establishment phase to promote healthy growth of native vegetation. Maintenance of the mitigation projects will also incorporate any issues and recommendations identified during monitoring activities.

3.8 Long Term Management and Adaptive Management

The Applicant will be responsible for the long-term management and adaptive management of the mitigation sites to ensure their continued success after the performance standards are initially met. Long-term management will include continued control of invasive species populations. Should site conditions change, negatively affecting the intended functions and success of a compensatory mitigation project, the Applicant will work with a consultant to identify issues hindering project success and develop and implement solutions that will achieve the permitted mitigation requirements.

3.9 Financial Assurances

The Applicant is an ideal candidate for permittee-responsible mitigation. PPL has sources of loans and funding from government and private organizations during construction. The NRC requires financial assurances from the PPL for the life of the facility including decommissioning at the end of its life-cycle.

4. Numerical Impact Summary for Jurisdictional Waters

Both DEP and ACOE require that wetland acreage be created or enhanced to compensate for permanently impacted wetlands. Temporary impacts do not require compensatory mitigation since they will be returned to their original condition. DEP and ACOE use different mitigation ratios to calculate minimum wetland replacement acreage. ACOE requires 2:1 for Palustrine Forested (PFO) wetlands, 1.5:1 for Palustrine Scrub Shrub (PSS), and 1:1 Palustrine Emergent wetlands (PEM). PADEP requires a minimum 1:1 mitigation for all wetland classifications (PFO, PSS, and PEM). Stream impacts also require a 1:1 mitigation ratio. The mitigation strategy will compensate for the following amounts of permanent wetland and stream impacts as well as indirect wetland impacts.

4.1 Permanent Impact Acreage

A summary of total wetland impacts, mitigation requirements and mitigation amounts for DEP and ACOE are provided in Tables 2 and 3, respectively. Permanent impacts resulting from bridge construction ranges from 0.01 to 0.09 ac each (ACOE jurisdiction) and 0.05 to 0.55 ac (DEP jurisdiction). Filling two small wetlands (Impacts I and J) will result in a total of 0.04 ac (ACOE) and 0.18 ac (DEP) of permanent impacts. Intake structure construction (Impact K) is the largest permanent wetland impact at 0.98 ac. Impact K will also cause the elimination of 617 LF of the NBC outfall channel. Construction of a culvert crossing for rail tracks will create 125 LF of permanent stream impacts. Permanent stream impacts from BBNPP construction will total 742 LF (ACOE). The Walker Run Mitigation Project will create 0.33 ac of permanent wetland impacts and 2799 LF of stream impacts that are included in the calculation of net wetland and stream gained. The wetland impacts result at locations where the proposed stream channel displaces existing wetlands. Stream impacts occur where the existing channel is abandoned. All planned wetland mitigation will create PFO habitat to compensate for indirect impacts and create forested wildlife corridors; therefore there will be a net loss of PEM wetland as shown in Tables 2 and 3.

Table 2. Summary of Wetland Impacts and Mitigation Requirements for DEP

DEP Impacts and Mitigation Summary	PFO (ac.)	PSS (ac.)	PEM (ac.)	**Total Wetland** (ac.)	**Total Stream** (lf)
Project Impacts	1.58	0.00	0.88	2.57	997
Project Impacts Requiring Mitigation*	0.51	0.00	0.88	1.39	742
DEP Minimum Mitigation Requirement (1:1)	**0.51**	**0.00**	**0.88**	**1.39**	**742**
Wetland Creation and Stream Creation/Enhancement	8.56	0.00	0.00	8.56	5012
Mitigation Impacts	0.08	0.00	0.25	0.33	2799
Net Wetland Creation and Stream Creation/Enhancement**	**8.48**	**0.00**	**-0.25**	**8.23**	**2213**
Net Gain	**7.97**	**0.00**	**-1.13**	**6.85**	**1471**

*Although DEP considers the entire bridge span a permanent wetland and stream impact, mitigation is only required for the bridge piers.
**DEP does not count wetland enhancement towards mitigation acreage.

Table 3. Summary of Wetland Impacts and Mitigation Requirements for ACOE

ACOE Impacts and Mitigation Summary	PFO (ac.)	PSS (ac.)	PEM (ac.)	Total Wetland (ac.)	Total Stream (lf)
Project Impacts	0.51	0.00	0.74	1.25	742
ACOE Minimum Mitigation Requirement (2:1 PFO, 1.5:1 PSS, 1:1 PEM)	**1.02**	**0.00**	**0.74**	**1.76**	**742**
Wetland and Stream Creation and Enhancement	15.36	0.00	0.00	15.36	5012
Mitigation Impacts	0.08	0.00	0.25	0.33	2799
Net Wetland Creation and Stream Creation/Enhancement	**15.28**	**0.00**	**-0.25**	**15.03**	**2213**
Net Gain	**14.26**	**0.00**	**-0.99**	**13.28**	**1471**

4.2 Temporary Impact Acreage

4.2.1 Physical Temporary Impacts

Temporary impacts resulting from excavation and grading around bridge piers will total 0.99 ac (DEP) and 2.18 ac (ACOE). The discrepancy in acreage results from the area of the bridge spans which DEP designates a permanent impact. Installation of the intake and blowdown pipelines result in 0.78 ac of temporary impact. All temporarily impacted areas will be returned to their original grade following disturbance activities and seeded with a wetland seed mixture. These activities do not require additional mitigation activities.

Additional stream temporary impacts result from Impact H, the replacement of the tear-drop wetland drainage culvert (567 LF); Impact M where the intake and blowdown lines cross the NBC (47 LF); and the NBSR river dredging for the intake forebay and the blowdown diffuser pipe (270 LF). These activities do not require additional mitigation activities.

4.2.2 Hydrologic Temporary Impacts

Dewatering for the construction of the safety-related structures may result in localized reductions in groundwater elevations, constituting a temporary wetland impact. To minimize this impact, preconstruction-monitoring of baseline conditions will be conducted, a temporary irrigation system will be installed to maintain baseline conditions during construction, and post-construction monitoring will be completed to ensure natural hydrology returns to the wetland. About 5.6 ac of Wetlands 11 and 12 will be irrigated as needed with the extracted groundwater through a sprinkler system. Pipes will also facilitate flow of the extracted water to about 1400 LF of Tributary 1 to Walker Run and Tributary 2 that may be impacted.

To effectively determine mitigation needs, baseline monitoring of hydrologic conditions within the zone of influence of pumping is required. A series of shallow piezometers and soil moisture monitoring devices will be installed in strategic locations and data collected for a minimum of two to three years will be used to complement data from existing flow gages and monitoring wells at BBNPP. Normalized with actual meteorological data inputs, this record of information will serve to determine volumetric and temporal mitigation needs during the pumping period.

Mitigation measures will include introduction of water to affected wetlands from one or more storage reservoirs constructed on the site to store pumped groundwater. Application of stored water will be completed by a sprinkler irrigation system, and continued monitoring of the wetlands will be completed to allow real-time flow corrections to maintain conditions reflecting the baseline.

Post construction evaluation of affected wetlands will be completed to determine if any additional restoration activities are required to offset any unintended impacts. In the unlikely event that the hydrology would not be restored to the affected wetlands following construction, the additional created wetland area provided exceeds the total area of wetlands that would be potentially affected by this impact. The compensatory mitigation program for BBNPP includes measures provided to offset any loss of function and value of affected wetlands during the period of impact from groundwater withdrawal. The entire "Construction Dewatering Mitigation Plan" is attached to this narrative.

4.3 Indirect Impact Acreage and Function and Value Replacement

Indirect impacts will affect 7.93 ac (DEP) and 9.00 ac (ACOE) of wetlands. Bridge construction will cause 1.93 ac (DEP) and 9.00 ac (ACOE) of indirect impacts. The difference in acreage results from the area of the bridge span which DEP designates as permanent impact. Indirect impacts resulting from intake and blowdown line installation total 0.07 ac and are also considered temporary. Transmission line construction and maintenance will create the greatest amount of indirect impacts, totaling 5.93 ac. The largest contiguous area of tree removal will occur within the "tear drop" wetland at Impact P where 3.46 ac of trees will be removed.

Any reduction in functions and values performed by indirectly impacting wetlands will also be replaced through the mitigation strategy. Cumulative PFO habitat loss is the greatest function affected by the proposed BBNPP. A total of 9.51 ac of PFO habitat will be cleared resulting in permanent, temporary, and indirect wetland impacts.

Impacts M, P, Q, and R will permanently change the type of wildlife habitat from PFO to PSS. Bridge impacts will result in both a permanent change in wetland cover from PFO to PSS (bridge spans) and temporary change in wetland cover (areas cleared for construction feasibility). Affects to wildlife habitat will be negligible from bridge construction since the impacted areas are a small portion of a large forested wetland complex. Impact K, a permanent impact associated with construction of the intake structure, will eliminate PEM and PFO habitat.

Impact K will also permanently impact the other functions and values provided by wetlands 43, 44, and the NBC outfall channel including floodflow alteration, fish habitat, recreation, educational value, uniqueness, and visual quality. The values associated with wetlands 43 and 44 are minimal because the wetlands are located along the access road to the SSES intake structure and not along a heavily used walking trail as many of the wetlands are within the Riverlands Recreation Area.

Fish habitat will also be affected by impact G, the railroad culvert crossing of the unnamed tributary to Lake Took-A-While.

The wetlands affected by Impact J do not perform any functions or values.

All other impacts will not affect wetland functions and values. Temporarily impacted PEM wetlands will recover their functions and values post construction. Table 4 quantifies acreages of impacted wetland functions and created or enhanced wetland functions resulting from BBNPP construction and planned mitigation.

Table 4. Wetland Functions Impacted and Created or Enhanced

Wetland Function	Amount Impacted	Amount Created/ Enhanced
PFO Wildlife Habitat	9.51 ac	14.60 ac
Fish Habitat	742 LF	2213 LF
Groundwater Recharge	0 ac	15.28 ac
Floodflow Alteration	0.98 ac	15.28 ac
Sediment Reduction	0 ac	15.28 ac
Sediment/Shoreline Stabilization	0 LF	2213 LF

The quantification of wetland values is more subjective. 0.98 ac of wetland will be impacted at the PPL Riverlands that provides the following values: education, recreation, uniqueness, and visual quality. The existing wetland at the impacted area is not easily accessible therefore the ability of the wetland to provide these values is weak. The proposed walking trail and NBC restoration will maximize these values by providing easy access for people to enjoy recreation, the educational and historical values of the wetland and canal and the aesthetics of the area.

6. Mitigation for Additional Project Impacts

6.1 Mitigation for Water Use Impacts

PPL has been working with the SRBC to determine a suitable method or combination of methods to mitigate BBNPP's proposed use of water from the NBSR during low flow periods. Mitigation may include a passby flow requirement and/or the release of water from existing or future PPL developed storage assets. PPL continues to actively work with SRBC on a mutually acceptable and beneficial plan but does not expect to finalize a mitigation plan for the BBNPP until 2012.

6.2 Upland Forest Clearing Mitigation Plan

PPL will reforest acreage both within and outside the site boundary to compensate for up to 234 ac of proposed forest clearing which includes 9.51 ac of PFO. PPL has identified priority areas for mitigation. Top priority includes the Walker Run mitigation site, crop fields north and east of Lake Took-A-While and west of the NBSR, and parcels on the east side of the NBSR. The reforestation goal is to provide north/south flyways on both sides of the project boundary, along Walker Run, and on the east bank of the NBSR between the river and the existing railroad tracks. This reforestation plan will be implemented in conjunction with the Indiana bat mitigation plan.

6.3 Indiana Bat Mitigation Plan

The NRC is the lead federal agency responsible for consultation under Section 7 of the Endangered Species Act with the United States Fish and Wildlife Service (USFWS) regarding federally listed threatened and endangered species. PPL is working cooperatively with the NRC and USFWS to develop a comprehensive mitigation and management plan for Indiana Bats. A multi-faceted mitigation plan is being prepared to compensate for the loss of potential Indiana bat habitat resulting from the tree clearing needed to support facility construction and grading. PPL expects to complete the development of the mitigation and management plan in 2011 at which point it will be filed for inclusion in the application record.

The mitigation plan will focus on ways to create, improve, and protect on- and off-site Indiana bat habitat.

PPL will create Indiana bat habitat through reforestation and will maintain/enhance Indiana bat habitat according to United States Fish and Wildlife Service (USFWS) guidelines. Lands within and outside the project boundary will be chosen with input from the USFWS. The reforestation and habitat conservation and management process will exceed specific pre-determined criteria to create suitable Indiana bat habitat.

Lastly, PPL will provide public outreach regarding the Indiana Bat and White Nose Syndrome through their environmental programming at the Riverlands Recreational Area and Wetland Nature Area.

6.4 Mitigation for Additional Species of Special Concern

Additional mitigation may be required for the butterfly species and mussel species of special concern indentified by the Department of Conservation and Natural Resources and the Pennsylvania Fish and Boat Commission. PPL is discussing the project with these agencies to determine potential impacts to the protected species and whether mitigation is necessary.

7. Conclusion

A total of 8.48 ac of wetlands will be created, 6.8 ac of wetlands will be enhanced, and 2213 feet of stream channel restored resulting in a net gain of 7.97 ac (DEP) and 14.26 ac (ACOE) of wetlands and 1471 LF of stream channel within the BBNPP property boundary. All impacted functions and values will be replaced. Additional wetland functions and values will be created exceeding those currently existing on the BBNPP site. The mitigation projects will create forested wetland habitat and improve habitat for reproducing wild trout populations within Walker Run. The proposed mitigation projects will exceed both DEP and ACOE mitigation requirements. PPL will satisfy additional Federal and State mitigation requirements by addressing impacts to endangered and protected species habitat.

Construction Dewatering Mitigation Plan

PPL Bell Bend Nuclear Power Plant
Salem Township, Luzerne County, PA

1. Executive Summary

Certain elements of the BBNPP infrastructure are proposed to be constructed in locations which will require dewatering to support completion of construction under dry conditions. The need to dewater prior to and during construction exists in part because the construction of critical safety-related structures will require excavation of soil and weathered rock as well as placement of engineered fill beneath foundations. This section will provide descriptions of dewatering activities, explain the impact that site activities will have on groundwater levels during and post-construction, discuss the environmental impacts that may result from dewatering, and explain proposed monitoring and mitigation measures.

During construction activities, three different site areas will be excavated down to competent bedrock. These three areas include the Power Block (Nuclear Island) area, the Essential Service Water Emergency Makeup System (ESWEMS) Pond area, and the area beneath the Cooling Towers. During excavation, variable amounts of groundwater will be encountered at each of these three areas. Because the excavation, backfilling, and construction activities need to be performed in dry conditions, temporary groundwater controls will be required during construction. The groundwater elevations will be drawn downward to below the deepest portion of each excavation with dewatering wells and/or sumps. Construction dewatering for the Power Block and Cooling Towers is anticipated to be minor and will be accomplished with a series of gravity drains and sump pumps. No adverse impacts to jurisdictional waters are anticipated as a result of construction dewatering in these areas.

Dewatering required for the construction of the ESWEMS pond will be more extensive, and is the subject of this narrative. Based upon computer modeling of groundwater levels in the vicinity of the proposed ESWEMS Pond, absent mitigation a depression of groundwater levels will occur over the multi-year pumping period. This depression would range from near-zero impact to many feet of groundwater elevation depression within wetlands nearby the source of withdrawal.

While a slurry wall will be constructed to aid in containing the aerial extent and depth of groundwater depression, this measure alone will not likely prevent adverse impacts to nearby wetlands and watercourses. Therefore, PPL is proposing to implement appropriate mitigation to maintain suitable hydrologic conditions in affected wetlands during periods of intense groundwater withdrawal.

To effectively determine mitigation needs, baseline monitoring of hydrologic conditions within the zone of influence of pumping is proposed. A series of shallow piezometers and soil moisture monitoring devices will be installed in strategic locations, and data collected during a baseline monitoring period will be used to complement data from existing flow gauges and monitoring wells at BBNPP. This record of information will serve as a benchmark for comparison to determine the mitigation needs during the pumping period.

Mitigation measures will include introduction of water to affected wetlands and/or watercourses, as needed, from one or more subsurface storage reservoirs constructed on the site to store pumped groundwater. Application of stored water will be completed by a temporary irrigation system, and continued monitoring of the wetlands will be completed to allow real-time flow corrections to maintain conditions reflecting the baseline.

Post-construction evaluation of affected wetlands will be completed to determine if any additional restoration activities are required to offset any unintended impacts. The compensatory mitigation program for BBNPP includes mitigation measures provided to offset any loss of function or value of affected wetlands during the period of impact from groundwater withdrawal.

2. Background

Avoidance of groundwater impacts was evaluated with regard to the placement of safety-related structures. Given the location of the main power block and the resulting location of the Bell Bend Switchyard, the Cooling Towers and the ESWEMS Retention Pond were placed in the only obvious locations. They must be located in the protected area, near the power block, and meet NRC design specifications. Within these constraints the facilities were sited to avoid permanently impacting the exceptional value wetlands.

The safety-related ESWEMS Retention Pond provides 27 days of makeup to the cooling tower basins. The total design volume of this pond includes the make-up water requirements (i.e. evaporation and drift) for the cooling towers, 30 days of seepage through the pond clay liner, and the volume of water lost to an ice cover. To satisfy these design requirements, the resulting pond measures 700 ft. by 400 ft. at grade level, contains at normal operating levels about 76.6 acre-ft of water and has a water depth of 17 feet. During construction the ESWEMS pond excavation is expected to fully penetrate the overburden soils and the upper weathered rock. The excavation will in a worst-case require removal of up to 56 feet of overburden and weathered bedrock.

The location of the ESWEMS Pond and the depth of the associated excavation requires a depression of existing groundwater elevations by over 50 feet to ensure dry conditions. An active dewatering system will be installed to support dewatering activities, which will be maintained continuously for up to 24 months. Analyses of the dewatering system requirements and modeling of predicted impacts to groundwater elevations is described in technical reports completed in 2010 (Ref. 1, 2).

3. Dewatering Activities

Dewatering will be accomplished through the installation of an active extraction system of wells and collection trenches situated at the interface of the overburden/rock interface. Additional passive dewatering via construction of collection trenches may also be necessary north of the nuclear island in the location of the proposed cooling towers. One or more sedimentation/detention ponds will be used to store extracted groundwater, and provide suitable treatment to ensure it is suitable for beneficial reuse.

A subsurface bentonite slurry flow barrier will be installed around portions of the areas to be excavated and dewatered. A continuous wall with its lowest elevation situated upon bedrock will be installed to contain the area of impact from dewatering.

The predicted volume of groundwater to be extracted would average 350 gallons per minute (gpm), which is equivalent to 0.5 million gallons per day (gpd). The period of dewatering will be concurrent with the period of time required to complete subsurface construction of the facilities in the area of groundwater extraction. This period is approximately two years.

3.1 Potential Impacts from Dewatering

Modeling of steady-state aquifer conditions under various scenarios was completed, using the Schlumberger Water Services Visual MODFLOW software (2009 version). Water flow budget and drawdown forecasts for dewatering using a flow barrier is the condition germane to the prediction of potential impacts to wetlands and streams, and is used as the basis for the evaluation of impacts presented here.

3.2 Area of Effect

The estimated area of detectable groundwater elevation depression within wetlands is depicted in Figure 1. This Area of Effect, focused to the west of the ESWEMS pond, includes approximately 5.6 acres of Wetlands 11 and 12 and approximately 1400 lineal feet of Tributary 1 to Walker Run and Tributary 2.

3.3 Extent of Impacts

The estimated level of groundwater elevation variation from "normal," or baseline conditions (described in Section 4.9) is expected to range from imperceptible at lower pumping volumes up to several feet of depression during maximum pumping conditions if mitigation measures are not implemented. In an unmitigated condition, this level of variation is likely to have an impact on hydrophyte growth and speciation as well as overall wetland biochemistry, and would affect the functions and values of the affected wetlands over the period of impact (Ref 3).

4. Monitoring Plan

Monitoring of hydrologic conditions and inputs are proposed as part of the dewatering impact evaluation and mitigation program in the pre-dewatering, active dewatering, and post-dewatering periods. The goal of the monitoring programs are to accurately establish baseline conditions, to ensure that mitigation actions mimic the baseline, and to evaluate any adverse impacts to affected wetlands following completion of dewatering activities.

Baseline conditions are herein defined as records of streamflow, shallow soil moisture levels, and groundwater (or perched water) elevations within the area of effect. The baseline will include these data, which PPL proposes to collect for a minimum two year period prior to the initiation of groundwater withdrawal. This data will be evaluated on a monthly, seasonal, and total average basis with applicable statistical analyses. The baseline data set will also include precipitation and temperature over the study period, allowing a generalized normalization of baseline to account for water balance inputs and outputs such as precipitation and evapotranspiration.

4.1 Monitoring (Pre-Construction)

Collection of data for the purpose of defining baseline conditions is proposed to be completed over a time span of at least two years. The determination of whether two full seasons of data is enough to establish pre-construction conditions or if augmentation of the data record is needed is dependent upon the level of variability observed within shallow groundwater and streamflow conditions during the first two seasons of monitoring.

Low variability in the hydrologic measurements collected will be taken as an indication that the data collected is suitable for use as a representative baseline condition that can be employed to guide mitigation measures designed to avoid long- and short-term hydrologic impacts to streams and wetlands within the Area of Effect. Moderate to high variability may dictate collection of additional data to ensure the baseline conditions captures a realistic range of hydrologic conditions.

The methods of data collection, as well as the interpretation and analysis of monitoring results will generally follow the standards set forth in the ACOE publication "Technical Standard for Water Table Monitoring of Potential Wetland Sites," a Wetlands Regulatory Assistance Program report (ERDC TN-WRAP-05-2) published in June, 2005.

Primary parameters to be collected as part of the monitoring program include shallow groundwater (or perched water) elevations, streamflow depths, and soil moisture.

The purpose of monitoring and baseline establishment for all 3 parameters is to support appropriate mitigation, with an operation goal of mimicking baseline conditions through direct addition of water following initiation of dewatering activities.

Figure 2 illustrates the proposed location of shallow wells (piezometers), stream gauges, and soil moisture probes, as well as the locations of existing piezometers and in-stream pressure transducers. The existing instrumentation has been recording data at 10 minute intervals since November 2009, and was installed to support other mitigation efforts.

Shallow groundwater will be measured through the installation of shallow groundwater wells, or piezometers. Six piezometers are proposed to be installed in the wetlands within the Area of Effect. These six piezometers will be installed along two transects spanning the wetland features located within the area of effect. Data logging pressure transducers will be installed in the piezometers and record shallow groundwater elevations to 0.01 ft increments at 10-minute intervals.

Two soil moisture probes will be installed on each transect, between the piezometers, for a total of four soil moisture sensors. Average soil moisture in the upper 12" of the soil profile will be measured. These probes will be connected to data loggers that will be set to record at intervals similar to the pressure transducers. These measurements will reveal whether or not shallow soils within the wetlands are between saturation and field capacity, being roughly equivalent to the range of appropriate growing season root zone wetland hydrology. The extent of saturation as well as the number of weeks during the growing season that saturated/moist soil conditions exists will add to the definition of baseline hydrology within the Area of Effect.

Streamflow monitoring at BBNPP has been ongoing in select areas since 2008. Flow depth has been recorded in 10-minute intervals at the locations shown in Figure 2 since November 2009. Flow within the streams located in the Area of Effect will continue to be monitored in four locations, as shown on Figure 2.

4.2 Monitoring (Active Withdrawal)

Following initiation of groundwater withdrawal continued monitoring of streamflow, shallow groundwater elevations, and soil moisture will be maintained. While the measurement and monitoring schedule is proposed to be the same during the pre-withdrawal period as during pumping, data will be downloaded and evaluated daily to determine the need for supplemental irrigation to maintain the baseline hydrologic conditions. Seasonal and diurnal fluctuations, as well as recent rainfall data will be evaluated on a daily basis and compared to baseline conditions for the current season and rainfall history. Deviation of the shallow groundwater depth, soil moisture, and/ or streamflow from the baseline conditions will serve as a trigger to initiate irrigation, as needed, to sustain the baseline hydrology.

4.3 Monitoring (Post-Construction)

Monitoring of identical parameters at the same frequency following completion of groundwater withdrawal activities is proposed to ensure that hydrologic conditions return to a steady-state condition. Post-construction monitoring data will be downloaded daily for the first two weeks following completion of dewatering activities, and weekly for an additional six weeks. After that time, monitoring will continue for at least the remainder of the growing season with monthly data download and comparison to baseline conditions. If the post construction monitoring results indicate a return to baseline conditions with no supplemental irrigation for the growing season following the completion of dewatering activities, then subsequent monitoring may be suspended.

5. Mitigation

Mitigation of potential negative impacts to wetlands and streams resulting from groundwater withdrawal is proposed via direct provision of makeup water. For the purposes of this project, successful mitigation is proposed to be achieved when observation of shallow groundwater, surface water, and soil moisture indicates that wetland hydrologic conditions within the Area of Effect mimic baseline conditions. Acceptable tolerances for groundwater elevations during pumping are proposed to be less than three inches difference between seasonally observed baseline water surface elevations from the same time period during pre-construction. Acceptable tolerances for stream flow depth are proposed to be less than two inches difference between seasonally observed flow depth during pumping and baseline conditions; however field judgment may need to be exercised during summer months when baseline conditions may indicate little to no flow. Acceptable seasonal ranges for each monitoring location will be established as part of the pre-construction monitoring work.

Makeup water to be used for mitigation will be supplied by the dewatering pumps and routed to an on-site settling basin to remove any entrained sediment. If wetland or streamflow observations indicate a reduction in flow requiring mitigation, water will be directly introduced to the affected stream channel or wetland via a temporary irrigation system. A schematic of the pumping and irrigation system is provided in Figure 3.

5.1 Mitigation Water Supply

Pumped groundwater from the construction dewatering operation will be discharged into the first cell of a two-cell holding pond. Each cell has the capacity to hold twenty-four hours of pumped water at the anticipated pumping rate. The total pond capacity is equal to two days of pumping volume. Overflow from the pond will be conveyed via a temporary swale to the downstream end of Wetland 11, from there it will be conveyed to Tributary 1 of Walker Run via a proposed culvert. The dewatering pumping rate will be approximately 0.7 cfs, so impacts to the existing downstream channels are not anticipated. The pond depth will be six to eight feet, and water will be drawn from the bottom to minimize thermal impacts.

5.2 Irrigation System

A temporary irrigation system will be installed with sprinkler heads on the east side of Wetland 11 and on the north side of Wetland 12. In addition, piping will be in place to supplement stream flow to the Tributary 1 of Walker Run and Tributary 2, as needed. The irrigation system will consist of four zones such that supplemental flow can be added to either wetland or stream independently based on the needs identified by the construction phase monitoring. Daily monitoring results will be compared to established seasonal baseline ranges and the irrigation system will be activated if actual conditions are below the acceptable ranges.

5.3 Maintenance of Baseline Conditions

As discussed in Section 4.1, establishment of baseline hydrologic conditions in on-site streams and wetlands is being completed to provide a reference condition towards which mitigation activities may be targeted. This baseline provides a multi-year, all-seasons reference to guide mitigation actions, including provision of makeup water to the affected areas.

Critical to the effectiveness of preventing adverse impacts to wetlands is ensuring mitigation activities correctly mimic baseline conditions. Continued monitoring of wetlands within the area of effect using the same monitoring points/devices and similar monitoring equipment is proposed to evaluate the success of mitigation actions and to serve as a positive feedback system to dictate changes in the type, extent, and duration of mitigation.

6. References:

- Construction Dewatering Design, Bell Bend Nuclear Power Plant, UniStar Nuclear Energy, Report No. SL-009655, Revision 2. Sargent & Lundy, LLC. November 23, 2010.
- Evaluation of Temporary Construction Dewatering Strategies, Proposed Bell Bend Nuclear Power Plant, Berwick, Pennsylvania. Weaver Boos Consultants North Central, LLC. October 20, 2010.
- *Wetlands, 2nd Ed.* William J. Mitsch and James G. Gosselink, 1993.


Legend
Proposed Roads
Excavation Contours
620
-5.0-
Groundwater Drawdown
Streams and Waterbodies
Existing Wetlands
Estimated Area of Dewatering Effect
Wetlands within Area of Dewatering Effect
Source:
Construction Dewatering Design Report for Bell Bend Nuclear Power Plant, Report No. SL-00965, Revision 2A, October 25, 2010 by Sargent & Lundy, LLC. Figures 16 & 20.
BBNPP plot plan information from Sargent & Lundy, LLC. SUPP. Drawing #SK-12198-400-001 Rev. 4. 9-9-10.
Flow Barrier
BNCH 718
BNCH 698
BNCH 678
BNCH 658
BNCH 628
BNCH 648
640
630
620
610
660
670
680
-35.0
10.0
5.0
25
0'
300'
600'
900'
SCALE: 1" = 300'
N
Figure :
Potential rea o
e atering a t
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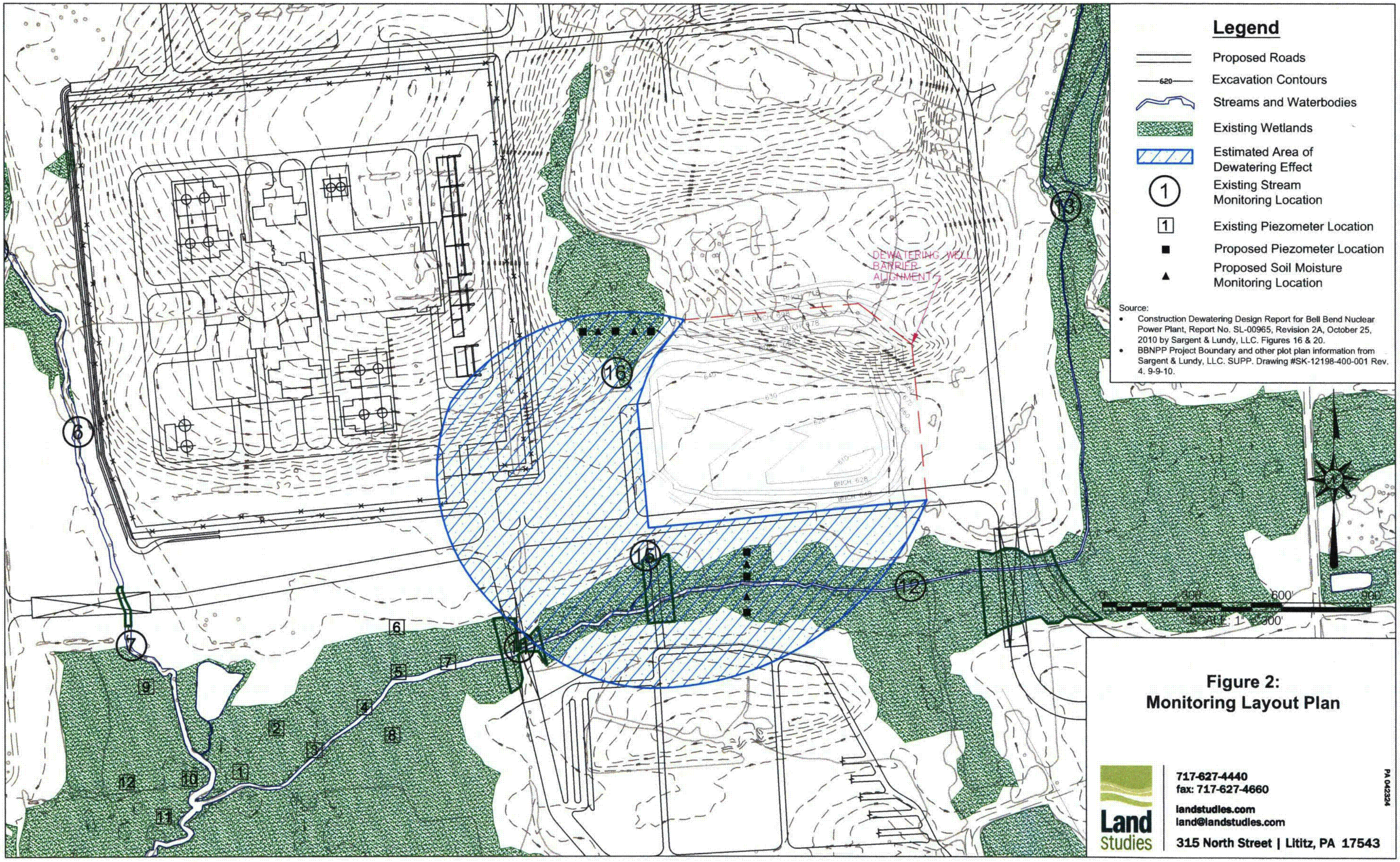

Figure 2:
Monitoring Layout Plan

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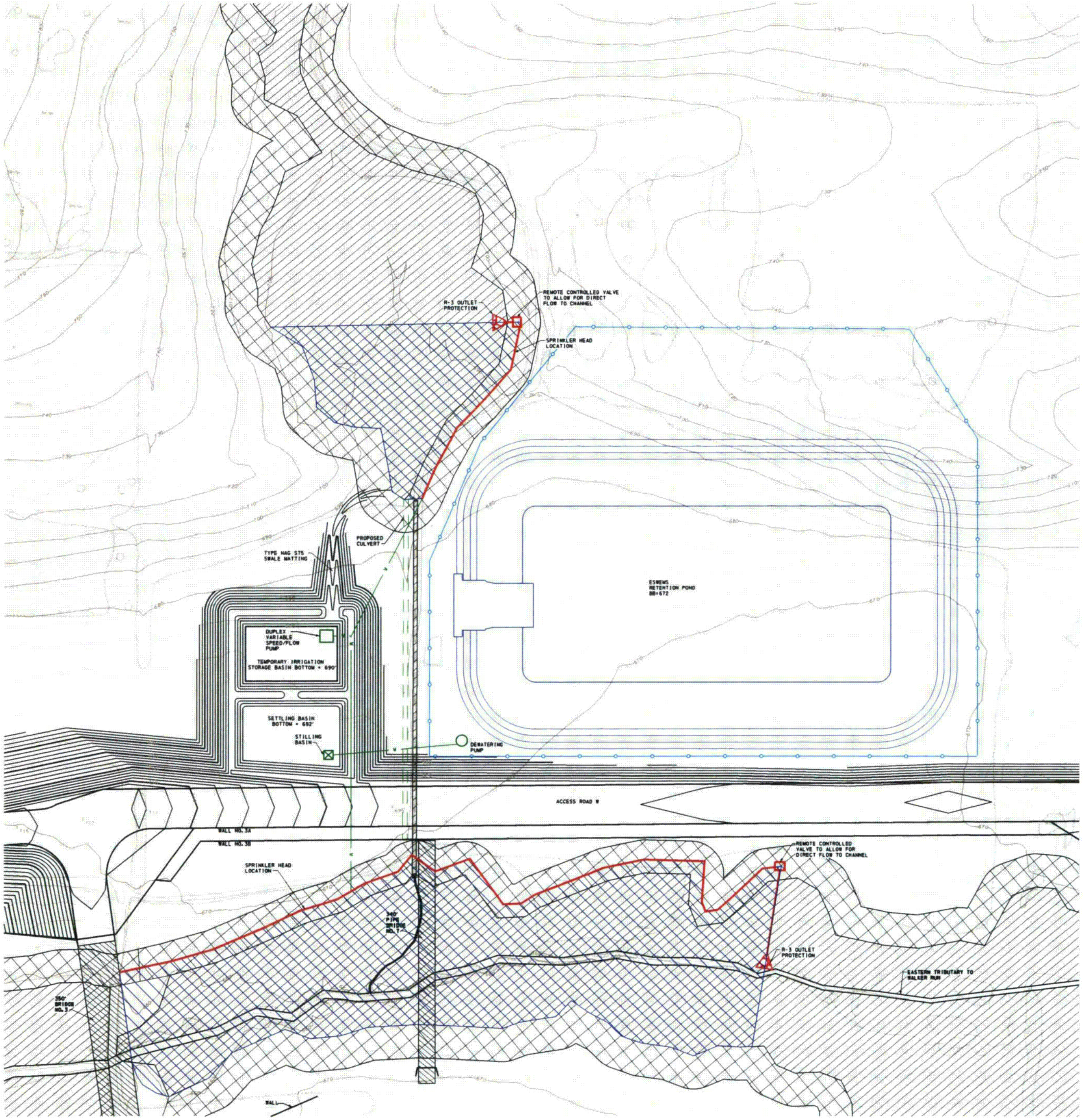

NOTES:

1. EACH BRANCH OF THE IRRIGATION SYSTEM WILL BE CAPABLE OF MITIGATING 350 GPM FROM THE DEWATERING OPERATION BY MEANS OF DIRECT DISCHARGE TO THE STREAM CHANNEL OR SPRAY IRRIGATION OF THE WETLANDS.
2. SPRINKER HEADS WILL BE SPACED 20' APART.
TEAR DROP WETLAND SPRINKLER HEADS WILL BE CAPABLE OF SPRAYING NO LESS THAN 22 GPM.
3. THE EASTERN TRIBUTARY TO WALKER RUN SPRINKLER HEADS WILL BE CAPABLE OF SPRAYING NO LESS THAN 6 GPM.
4. EACH SPRINKLER HEAD WILL HAVE AN OPERATIONAL PRESSURE OF 30-40LBS/SQ-IN.
5. THE DUPLEX VARIABLE SPEED/FLOW PUMP WILL BE CAPABLE OF PUMPED NO LESS THAN 350GPM.
6. THE DEWATERING POND WILL HAVE TWO DAYS OF STORAGE.
7. THE FIRST BAY WILL HAVE THE CAPACITY TO ALLOW THE PUMPED WATER TO SETTLE FOR 24HRS.
8. THE SECOND BAY HAVE THE CAPACITY TO ALL IRRIGATION FOR 24HRS.
9. THE POND HAS AN EMERGENCY SPILL WAY THAT WILL ALLOW UNNECCESSARY WATER TO PASS TO THE STREAM CHANNEL.

LEGEND

REMOTE CONTROLLED VALVE TO ALLOW FOR DIRECT FLOW TO CHANNEL

DUPLEX VARIABLE SPEED/FLOW PUMP

STILLING BASIN

DEWATERING PUMP

SPRINKLER SPRAY ZONE

50' EXCEPTIONAL VALUE (EV) WETLAND BUFFER

WETLANDS

SPRINKLER HEAD LOCATION

WATER LINE

FLOW BARRIER

R-3 OUTLET PROTECTION
Do = 1, W = 5,
La = 4, 18" THICK

ROCK SIZE DISTRIBUTION TABLE			
	GRADED ROCK SIZE (IN)		
NSA NO.	MAX.	D50	MIN.
R-3	6	3	2

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Engineers • Surveyors • Planners • Landscape Architects
100 N. Wilkes-Barre Blvd, Suite 409, Wilkes-Barre, PA 18702
TEL: 570-824-2200 FAX: 570-824-0800

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BELL BEND NUCLEAR POWER PLANT
SALEM TOWNSHIP, PENNSYLVANIA

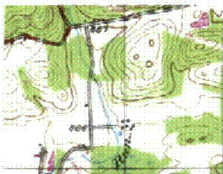
DEWATERING / TEMPORARY SPRAY IRRIGATION PLAN

PPL BELL BEND, LLC
38 BOMBOY LANE
SUITE 2
BERWICK, PA 18603

SCALE 1"=60'
DRAWN BY WCK
DATE 04/05/11
APPROVED JPM
SHEET 1 OF 1
DRAWING NO. DE-WATER

Bell Bend Nuclear Power Plant
Stream and Wetland Mitigation Design Report
Walker Run Site

Salem Township, Luzerne County, PA



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38 Bomboy Lane, Suite 2
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Prepared by:

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Rev 0, November 2010

Table of Contents

1 Introduction

The proposed stream and floodplain restoration includes approximately 3,440 linear feet of Walker Run located on the Bell Bend Nuclear Power Plant (BBNPP) development site, which is owned by PPL in Salem Township, Luzerne County, Pennsylvania (*see Figure 1-1*). The purpose of the project is to provide mitigation for proposed stream and wetland impacts associated with the BBNPP development. The proposed stream and wetland mitigation plan for the Walker Run site utilizes natural stream channel design (NSCD) techniques, which are consistent with the Keystone Stream Team's Guidelines for Natural Stream Channel Design for Pennsylvania Waterways, March 2007, to improve channel stability, water quality, and aquatic habitat along the project reach and to restore the functionality of the floodplain. The proposed design includes approximately 4,774 linear feet of restored stream channel, approximately 5.5 acres of enhanced wetlands, and approximately 8 acres of created wetlands creation.

As part of the restoration design effort, LandStudies completed a preliminary visual assessment and a detailed geomorphic assessment of Walker Run watershed to better understand the existing hydrology, hydraulics, and stream morphology of the project reach. The assessment also included a historic investigation of the watershed, which identified how past impacts to the stream/floodplain have influenced the current degradation and instability observed along the project reach. Understanding the causes of this instability is crucial for developing an effective solution/design. The proposed design was developed using information provided by the detailed geomorphic assessment of the Walker Run watershed as well as data collected at assessment reach locations within similar watersheds that exhibited signs of stability. This design report presents the design methodology and summarizes design calculations involved with the proposed restoration of Walker Run. The specific design objectives include:

1) Create a stable system using the principles of fluvial geomorphology to improve channel stability along the Walker Run Project Reach;
2) Create varying in-stream conditions that are ideal for both trout habitat and spawning.
3) Improve water quality by reducing bank erosion and by creating a vegetated floodplain with elevations closer to the seasonal water table that may store and treat surface runoff;
4) Provide flood flow storage and infiltration opportunities in the restored floodplain;
5) Improve aquatic and riparian habitat;
6) Reduce non-point source pollution, including sediment, nutrient and thermal pollution;
7) Provide a floodway that reduces the current flood flow elevations

These objectives have been achieved through the following tasks:

1) Analysis of the existing stream channel system and watershed and assessment of the influence of historical impacts on the current state of stream stability;
2) Obtaining and analyzing morphological data to characterize bankfull and flood flow conditions, determining boundary and critical shear stress limits, collecting sediment characteristics data including riffle particle texture and distribution, and computing stream morphological classifications; and
3) Development of a restoration design that integrates geomorphologic and hydraulic/sediment transport concepts to provide a stable channel and floodplain that enhances the riparian corridor.

The Walker Run project reach consists of two separate segments including: 1) Site A – beginning at the Beach Grove Road bridge and ending at the north Market Street bridge; and 2) Site B – beginning at the north Market Street bridge and ending near the existing treeline approximately 300 feet downstream from the existing farm pond on the BBNPP development site. Proposed design parameters were developed to accommodate existing valley characteristics at each site and to create varying in-stream conditions that favor both trout spawning (Site A) and trout habitat (Site B).

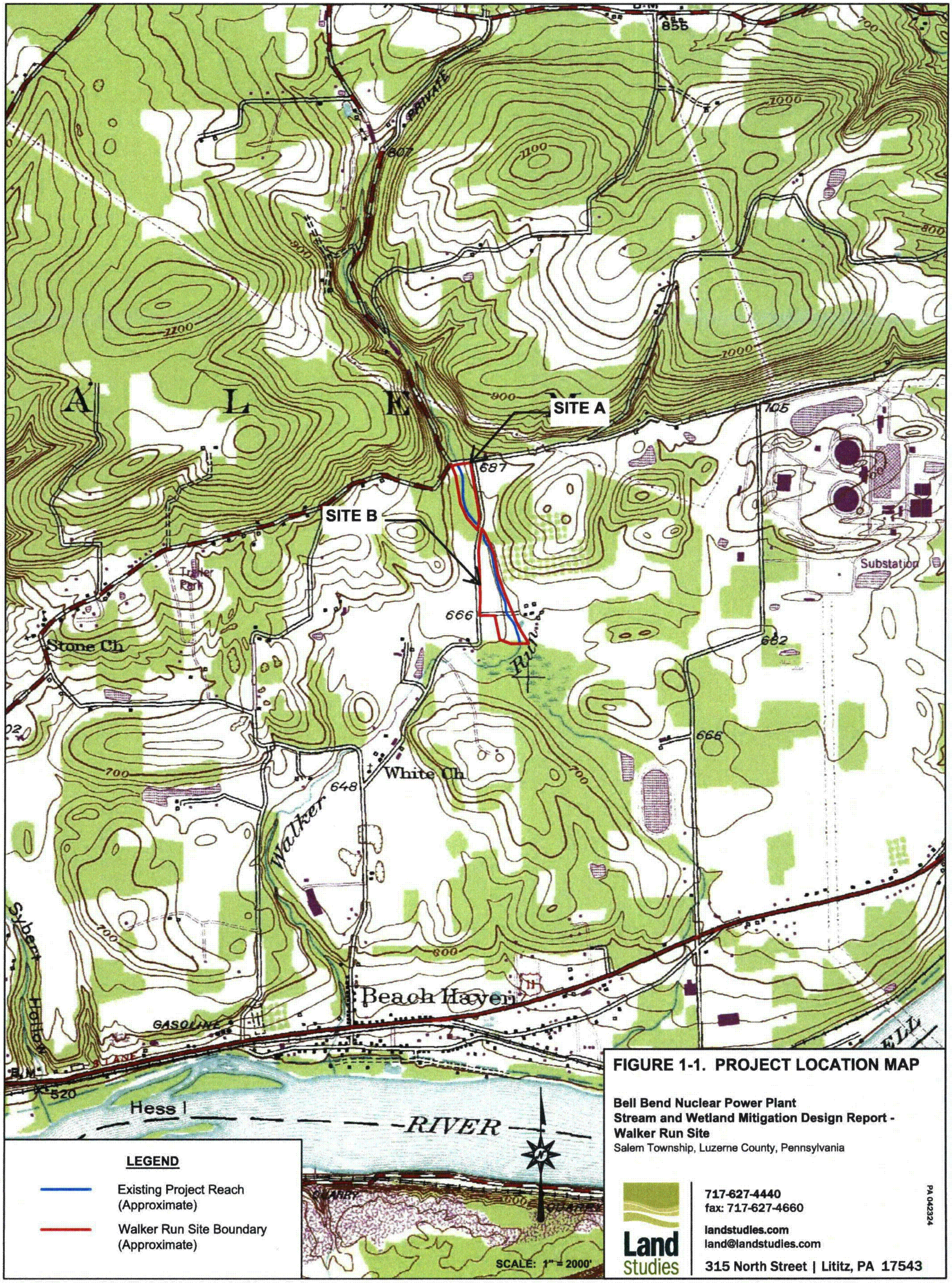

FIGURE 1-1. PROJECT LOCATION MAP

Bell Bend Nuclear Power Plant
Stream and Wetland Mitigation Design Report - Walker Run Site
Salem Township, Luzerne County, Pennsylvania

LEGEND

- Existing Project Reach (Approximate)
- Walker Run Site Boundary (Approximate)

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2 Physiographic Region, Hydrology, Geology, Sediment Supply and Existing Land Use

2.1 Physiographic Region

The project site is part of the Susquehanna Lowland Section of the Ridge and Valley physiographic province (*see Figure 2-1*), which is characterized by a distinctive series of linear ridges and valleys that are the result of differential erosion of folded sedimentary rocks with varying degrees of resistance to weathering and erosion. Valleys are composed of less resistant rocks such as limestone and shale, whereas ridges and uplands are composed of more resistant rocks, particularly sandstone and siltstone. The Susquehanna River has incised into and crosses these ridges as it flows generally from north to south, and its numerous tributaries form a trellis drainage network pattern as they flow along the valleys underlain by less resistant rocks.

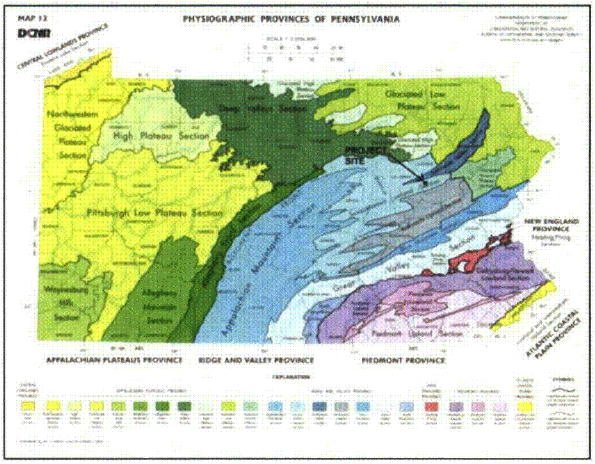

Figure 2-1. Physiographic Provinces Map of Pennsylvania

2.2 Hydrology

Walker Run is a perennial stream that flows into the North Branch Susquehanna River approximately 2 miles downstream from the project reach. The North Branch Susquehanna River confluences with the West Branch Susquehanna River near Sunbury, Pennsylvania to form the main branch of the Susquehanna River, which ultimately flows into the Chesapeake Bay. Multiple springs, rainfall, and snowmelt influence the stream flow of the project reach. Bankfull and higher flows may occur as a result of a variety of rain events, including rain or snow, frontal storm events, and occasional tropical storms. The project reach also receives stormwater runoff from some impervious surfaces adjacent to the project area. The drainage area to the upstream limit of the project reach is approximately 2.0 square miles. The drainage area to the downstream limit of the project reach is approximately 2.4 square miles (see *Figure 2-2*). Walker Run is listed as a Cold Water Fishery (CWF) and Migratory Fishes (MF) stream by the PADEP Water Quality Standards (25 Pa. Code Chapter 93, Drainage List K (25 § 93.9k)) and currently supports reproducing brown trout populations; therefore all wetlands that are hydrologically connected to Walker Run are considered to be exceptional value wetlands.

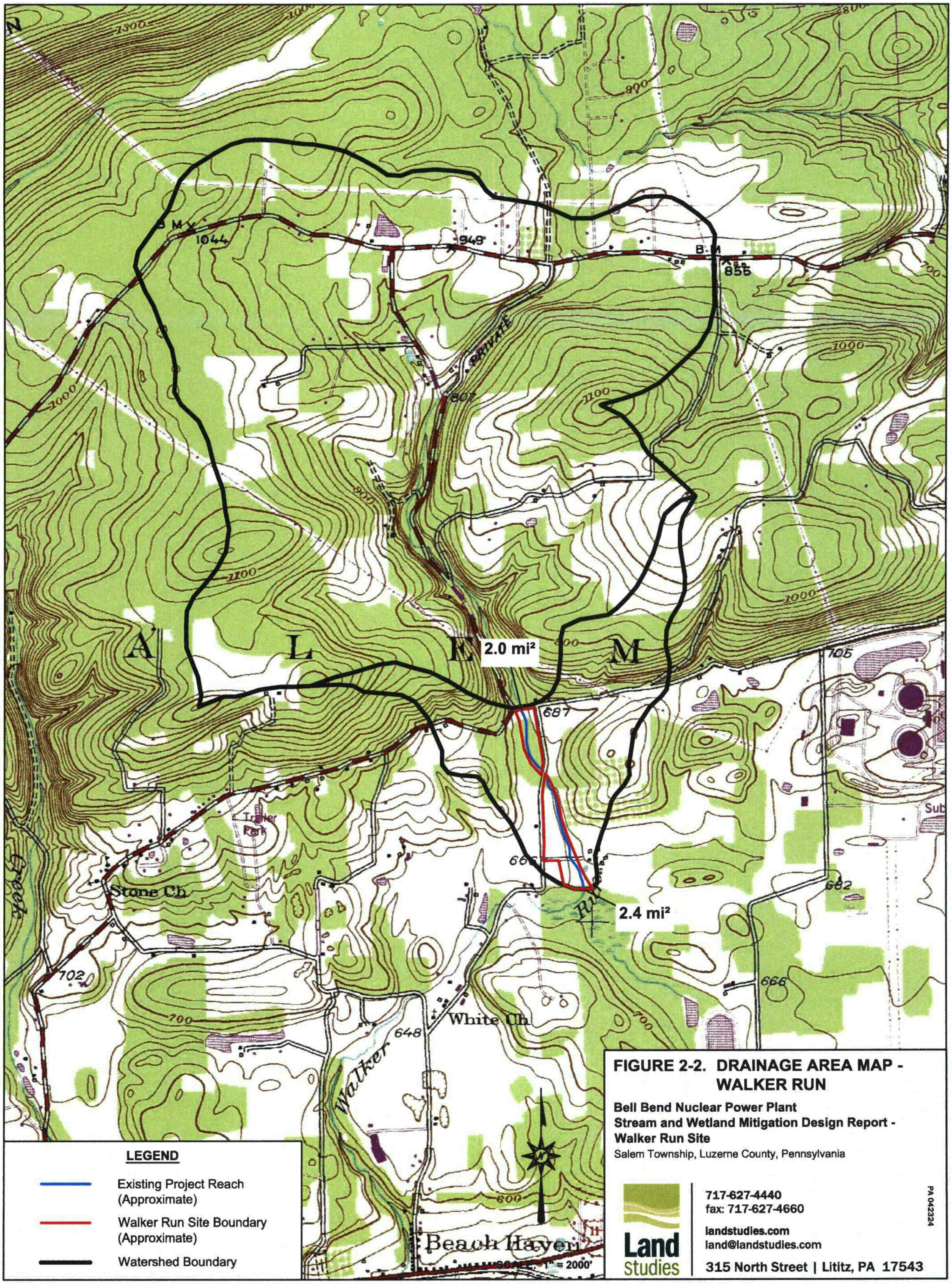

FIGURE 2-2. DRAINAGE AREA MAP - WALKER RUN

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2.3 Geology and Sediment Supply

The underlying bedrock of the Walker Run project reach watershed consists of five distinct geologic formations that are composed of Devonian-age sedimentary rocks including various types of sandstone, siltstone, shale, and claystone (*see Figure 2-3*). These formations trend generally in a northeast to southwest direction from southern Luzerne County towards Harrisburg. Also, there are five Quaternary-age surficial geologic formations that exist throughout the watershed (*see Figure 2-4*), which were deposited more recently as a result of glacial and fluvio-glacial activity. *Table 2-1* briefly describes both bedrock and surficial geologic formations. Bed materials within the Walker Run may be derived from any of these formations as well as any fine-grained sediment that have accumulated in the valley bottoms as a result of more recent human influences such as clear-cutting, dams, and farming.

During the past 2 million years (approximate), the landscape has been modified by cyclical erosion and deposition associated with advancing and retreating ice sheets, up to several kilometers thick in places, which flowed southward from the northern polar regions. The most recent ice advance, known as the Wisconsinan, occurred about 45,000 to 15,000 years ago. The most recent part of this advance is referred to in this region as the Woodfordian, which is responsible for creating the most prominent glacial features in the Walker Run watershed and the surrounding region. These features include a northwest-southeast trending Woodfordian terminal moraine complex that consists of boulder, poorly sorted sediment, and Woodfordian glaciofluvial (including kame) terraces along the Susquehanna River that consist of stratified sands and gravels. "Kame terraces are frequently found along the side of a glacial valley and are the deposits of meltwater streams flowing between the ice and the adjacent valley side. These kame terraces tend to look like long flat benches, with a lot of pits on the surface made by kettles. They tend to slope down-valley with gradients similar to the glacier surface along which they formed, and can sometimes be found paired on opposite sides of a valley" (definition provided by www.wikipedia.org). The terminal (end) and ground moraines deposited at the front of and beneath the ice sheet, respectively, are much coarser than the outwash sediments, and also are marked by kettles. Kettles are depressions on the ground surface that resulted from melting of ice blocks within the glacial deposits during deglaciation. After deglaciation, which ended approximately 10,000 yrs ago, the landscape of the Walker Run watershed was mantled with fresh glacial and near-glacial deposits, which consisted of kame terrace sediments that were deposited along the sides of river valleys adjacent to ice margins, and of various types of till and outwash that formed at the leading edge of the Woodfordian ice sheet. Drainage was poor as a result of the near-glacial and glacial deposits, which typically consist of sediment that ranges from clay- to boulder-size, and resulted in widespread swampy conditions as streams adjusted to deglacial conditions.

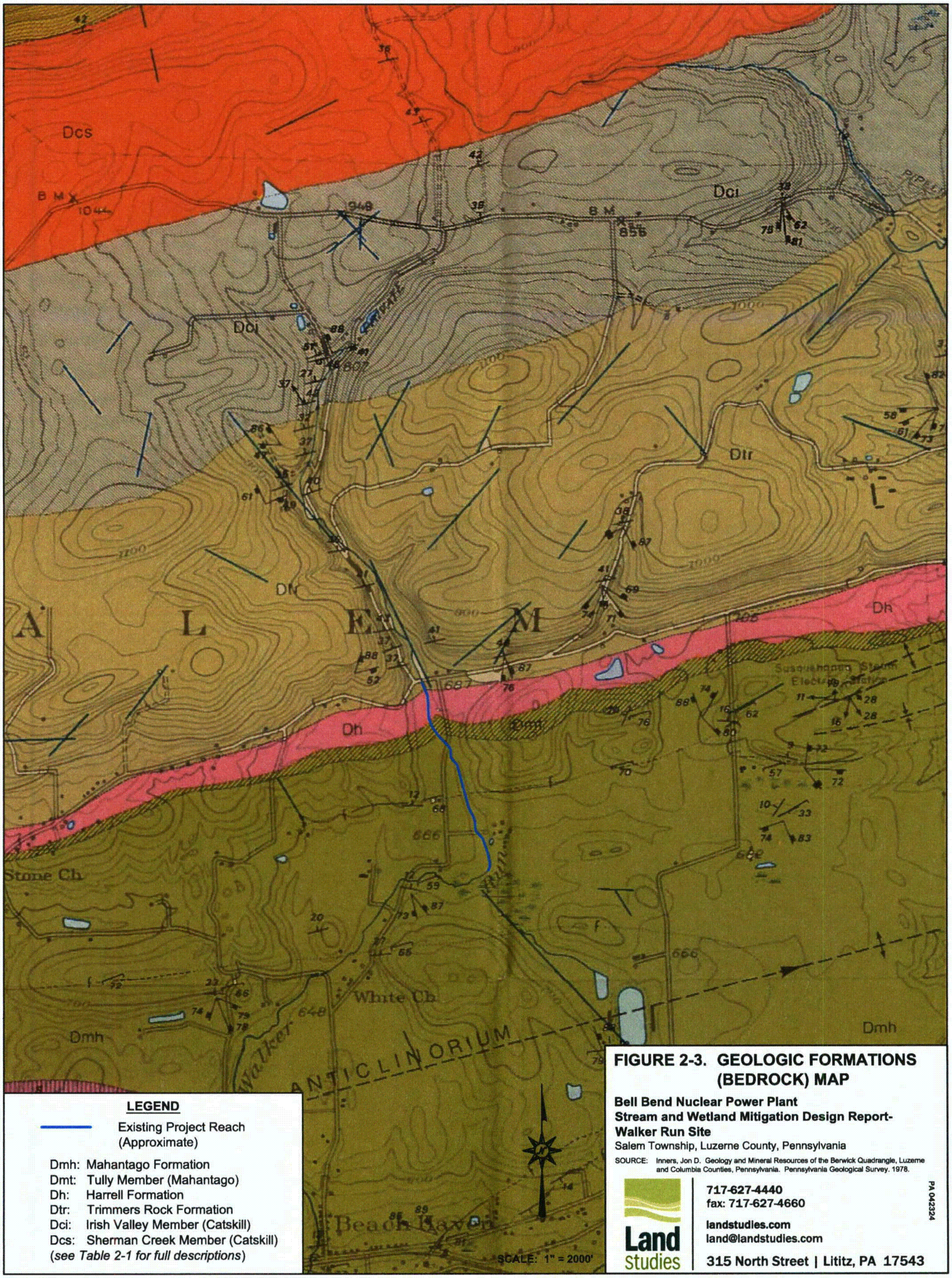

FIGURE 2-3. GEOLOGIC FORMATIONS (BEDROCK) MAP

Bell Bend Nuclear Power Plant
Stream and Wetland Mitigation Design Report-Walker Run Site
Salem Township, Luzerne County, Pennsylvania

SOURCE: Inners, Jon D. Geology and Mineral Resources of the Berwick Quadrangle, Luzerne and Columbia Counties, Pennsylvania. Pennsylvania Geological Survey. 1978.

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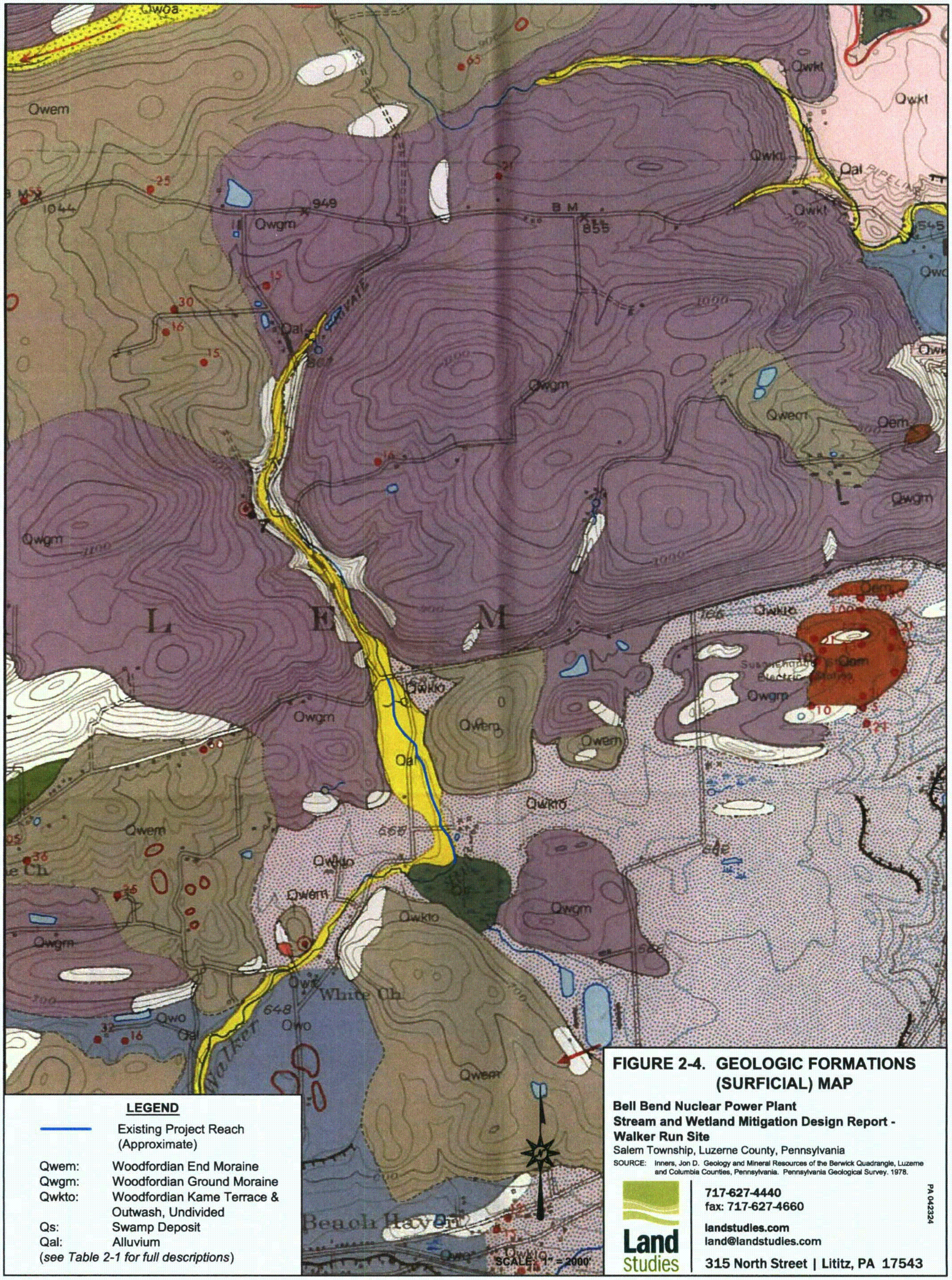

LEGEND

(blue line)	Existing Project Reach (Approximate)
Qwem:	Woodfordian End Moraine
Qwgm:	Woodfordian Ground Moraine
Qwkto:	Woodfordian Kame Terrace & Outwash, Undivided
Qs:	Swamp Deposit
Qal:	Alluvium

(see Table 2-1 for full descriptions)

FIGURE 2-4. GEOLOGIC FORMATIONS (SURFICIAL) MAP

Bell Bend Nuclear Power Plant
Stream and Wetland Mitigation Design Report - Walker Run Site
Salem Township, Luzerne County, Pennsylvania

SOURCE: Inners, Jon D. Geology and Mineral Resources of the Berwick Quadrangle, Luzerne and Columbia Counties, Pennsylvania. Pennsylvania Geological Survey. 1978.

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	Formation Name	Abbrev.	Age	Description
Bedrock Formations	Mahantago Formation (includes Tully Member)	Dmh Dmt (Tully)	Devonian (360-408 million yrs.)	Dark-gray silty claystone (95%) with some argillaceous, fine-grained limestone (5%) in uppermost part.
	Harrell Formation	Dh	Devonian (360-408 million yrs.)	Dark-gray to grayish-black clay shale and silty clay shale.
	Trimmers Rock Formation	Dtr	Devonian (360-408 million yrs.)	Dark-gray, fine-grained sandstone (25%), dark-gray siltstone and silt shale (60%), and dark-gray silty clay shale (15%).
	Irish Valley Member (Catskill Formation)	Dci	Devonian (360-408 million yrs.)	Grayish, fine-grained sandstone (30%), greenish-gray and grayish-red siltstone (20%), grayish-red silty claystone (30%), and greenish-gray silty clay shale (20%).
	Sherman Creek Member (Catskill Formation)	Dcs	Devonian (360-408 million yrs.)	Greenish-gray and grayish-red fine- to medium-grained sandstone (50%) and grayish-red siltstone and silty claystone (50%).
Surficial Formations	Woodfordian End Moraine	Qwem	Pleistocene (10,000 yrs.-1.6 million yrs.)	Till (unsorted mixture of clay, silt, sand, gravel, cobbles, and boulders); well-developed depositional topography; surface is hummocky with many closed depressions (kettles); up to 100' thickness.
	Woodfordian Ground Moraine	Qwgm	Pleistocene (10,000 yrs.-1.6 million yrs.)	Till (unsorted mixture of clay, silt, sand, and gravel, with many cobbles and boulders); vague depositional topography; 10-15' average thickness.
	Woodfordian Kame Terrace and Outwash, Undivided	Qwkto	Pleistocene (10,000 yrs.-1.6 million yrs.)	Predominantly sand, gravel, and cobbles with some boulders; kame terrace and outwash deposits are undifferentiated; thickness ranges is 10-100'.
	Swamp Deposit	Qs	Holocene (present-10,000 yrs.)	Organic silty clay with some peat; water-saturated; surface of deposits flat to slightly hummocky; thickness unknown; located in undrained or poorly drained depressions in glaciated terrain.
	Alluvium	Qal	Holocene (present-10,000 yrs.)	Mostly sand, silt, and gravel, with some cobbles and boulders; typically less than 6' thick in tributary valleys.

Table 2-1. Bedrock and surficial geologic formations located within the Walker Run watershed.

2.4 Existing Land Use

The project reach is located entirely within the proposed BBNPP development site owned by PPL. The valley bottom consists of mostly agricultural fields (both active and fallow) with some forested areas at the upstream portion of the project reach. Dominant land cover on the existing side slopes includes forest, scrub-shrub, open meadow, and agricultural fields. A road (Market Street) and some small residential homes are adjacent to the west boundary of the project area. The Walker Run restoration site will be left as a natural open space area after construction.

3 Historical Land Use and Potential Sources of Stream Instability

3.1 Pre-Settlement Conditions

Before European settlers arrived in the Middle Atlantic Region of the United States, the landscape was dominated by forests of mixed hardwoods, conifers, and a variety of woody and herbaceous flora, from mountain peaks down to the valleys and streams and rivers. The characteristics of pre-settlement soils suggest that the valley bottoms were broad, forested wetlands with small, shallow and anabranching and chain-of-pool streams that experienced frequent overbank flow (Walter and Merritts, 2008). These conclusions are consistent with accounts by early explorers that found swampy meadows and marshes, fed by springs at the base of valley side-slopes (Kalm, 1987). In stream and river valleys, floodplains were wide and fairly flat. Floodplain soils were thin, peaty, and loamy - rich with organic material and highly porous, allowing abundant infiltration of surface water, which then percolated down to groundwater supplies. In these valleys, groundwater flowed near the floodplain surface, contributing to the base flow of the streams. The floodplain surface typically rose only slightly above the stream channel base flow water surface elevation. The typical pre-settlement scenario, then, looked something like the conditions shown in *Figure 3-1* - relatively narrow stream channels meandering through the lower elevations of the valleys.

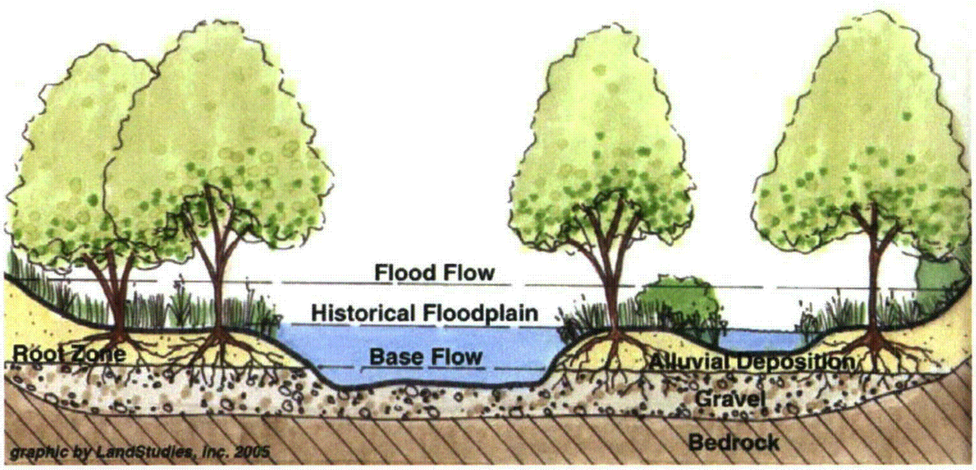

Figure 3-1. Stable, pre-settlement stream and floodplain systems were characterized by: a low floodplain in close contact with surface water in the stream channel, allowing for frequent inundation of the floodplain during high flows; riparian vegetation with root zones in contact with ground water that enabled groundwater denitrification through root uptake; and a channel bed composed of cobble and gravel, which helped protect the bed from erosive flow forces.

Channel flows intersected with groundwater during times of high base flows and recharged groundwater during drought or normal base flow conditions. Low, frequently inundated floodplains consisted of porous, well-vegetated soils. Root systems throughout the floodplain reached down to the groundwater and streambed elevations, the root zone providing a large surface area for pollutant removal from groundwater and surface water. Floodplains also served as a major recharge area for surface flow because of their porous material that held and gradually infiltrated flood flows from the channel as well as overland flows.

This scenario is nature's design for a fully functioning stream system that holds its stability while helping control storm flow and purifying water supplies. The constant interaction among the various components - surface water, groundwater, soil, and vegetation - is what is required to allow a stream channel, its floodplain, and the attendant wetland pockets to provide the benefits of a fully functional system. And this is how stream channels and floodplains in the Walker Run watershed probably looked like and functioned before European settlers arrived and began to alter the landscape.

3.2 Early Historical Impacts

The Walker Run watershed exhibits effects of colonial and post-colonial (early 1700s to 1930s) land-use practices that are commonly found throughout the Eastern United States. Wholesale land clearing and poor farming practices led to widespread erosion of uplands and massive deposition of soils in the stream valleys (Caverns 1925, Costa 1975, Jacobson and Coleman 1986) (*see Figure 3-2*).

Figure 3-2. Indiscriminate land clearing caused massive erosion from hillsides.

Stream channel beds and floodplains, including tributaries, grew artificially high, perched on the fine-grained eroded materials. Elevated channel beds and floodplains were no longer closely connected to groundwater supplies; therefore, flows were composed predominantly of surface water runoff, with temperatures far exceeding that of the groundwater. Over time, the channels vertically degraded through the accumulation of fine-grained sediments leaving abandoned floodplain terraces with elevations well above the channel bed. Additionally, to make it easier for farming and/or other human activities, meandering stream channels were moved from the lowest elevations in the valley centers to the higher elevations at valley edges, and in the process were typically straightened. It was common Vegetation changed because of the disconnection of the newly elevated floodplain in relation to the elevation of the stream channel. Wetland systems were created not because of their proximity to groundwater but because they sat on dense, fine, nearly impervious sediments perched high above the streambed and groundwater. No longer could those wetland plants extend their root systems into the groundwater to remove the nitrogen compounds.

As a result, many floodplains in the Eastern United States do not actually function as floodplains are intended to in stable, natural channel environments. Rather, these current surfaces are at elevations that are too high above the stream's ordinary high water mark to provide effective and frequent flood-flow conveyance and attenuation. Streams are typically deeply incised, or entrenched, with high vertical streambanks composed of fine-grained, easily-erodible sediments (see *Figure 3-3*).

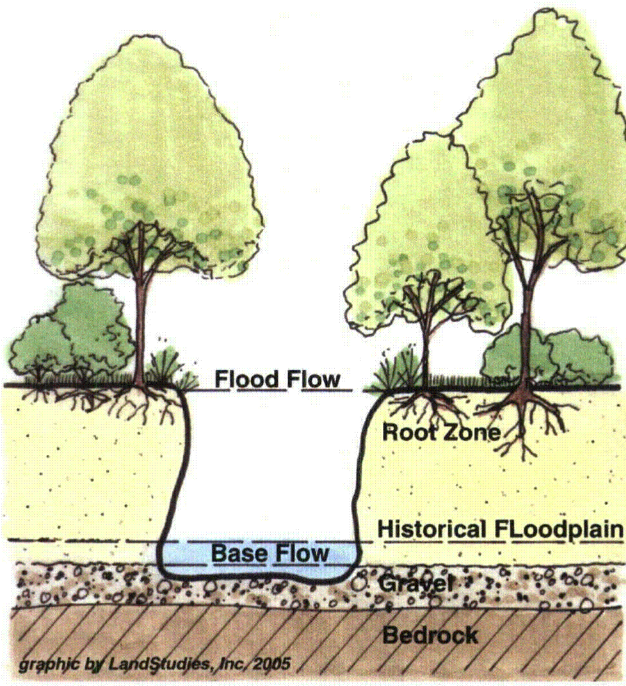

Figure 3-3. Stream channels are eroding or have eroded down through post-settlement sediments, leaving their alluvial floodplains high above the current base flow water elevation, and disconnecting riparian root systems from groundwater flows. The processes of frequent floodplain inundation, relieving in-channel stresses; groundwater infiltration through porous floodplain material; and nitrogen removal from groundwater through root systems are lost under these conditions that are prevalent today throughout the northeast United States.

Most high flows are contained within the channel, which creates high shear stresses along the bed and banks and subsequently, high bank erosion rates. As a result of this channel instability, large accumulations of fine-grained sediment are introduced into the stream channel during high flow events, which lowers water quality and, in turn, negatively affects the existing aquatic habitat.

3.3 Existing Conditions

In many cases, the causes of channel instability are directed related to past human impacts such as clear-cutting, poor farming practices, construction of mill dams/ponds, ditching or channelization, and road or railroad development. In the case of Walker Run, several of these impacts may have influenced the present instability along the project reach. However, it is likely that the most significant influence was the relocation of the channel to man-made ditches along the edges of the valley to improve farming accessibility and/or to increase farmable acreage. As a result, the channel is disconnected from its floodplain and bank failure is common during high flows. As the stream migrates laterally, gravel imbedded in the banks is displaced and deposited locally forming point bars along the opposite banks from the degrading cut banks or mid-channel bars in the stream. The point bars become vegetated because they are low enough in elevation to convey flood flows without degrading. This process would continue until the stream channel has eroded enough sediment to create a low-lying wide stable floodplain. However, until this stability is achieved, the eroded fine-grained sediments will continue to be washed into the stream and pollute the downstream watershed.

To better understand the soil stratigraphy and surficial deposits of the project site, trenches were excavated perpendicular to the stream channel to depths up to 6 feet. While the trenches were open, a soil stratigraphy analysis and geomorphic investigation was performed by Dr. Dorothy Merritts of Franklin & Marshall College. During the field analysis, a series of elevations were surveyed including the ground surface, the bottom of the historic sediments (post-settlement deposition beginning in early 1700's), and the top of the pre-settlement gravelly bed material. Based on these field measurements, it is estimated that approximately 1-4 feet of historic sediments exist along the floodplain of the project reach (*refer to Geomorphic Assessment of Sediment and Soils along Walker Run, Berwick in Appendix A*). Based on the results of this analysis, the existing bed elevations of the project reach are lower than the top of the pre-settlement gravels, which indicates that the present stream channel either downcut or was artificially ditched to elevations well below the bottom of historic deposits and into unsorted glacial deposits and post-glacial alluvium. The glacial and post-glacial deposits vary dramatically in size from sandy clays to boulders. The geomorphic assessment of the soil stratigraphy is important for the restoration design because the proposed bed elevations of the project reach were correlated to the pre-settlement stream bed elevations.