September 23, 2010

Scientists, Engineers & Environmental Planners Designing Innovative Solutions for Water, Wetland and Soil Resource Management

MEMORANDUM

To: **Raquel Ketterman**
From: **Laura Wildman**
cc: **Serena McClain**
Jim Thompson

Re: **Cumberland Dam Phase I Summary**
Potomac River
Cumberland, MD
Project No. 1033.001

The project team has completed the field work and investigation for Phase 1 of the Cumberland Dam Feasibility Study, including the initial field investigation, sediment probing, sediment sampling and analysis, preliminary investigation on dioxins, bathymetric survey / mapping, bedrock and site geology, historic assessment, structural interconnectivity of the dam and bridge, C & O Canal Pumping Station, fisheries and species of special concern, firefighting, socio-economic factors, and recreational opportunities. Important information about firefighting needs and socio-economic issues was provided by the MD DNR and the City of Cumberland staff. A brief review of the public meeting held on 16 August 2010 is also provided.

Field Investigation

Princeton Hydro staff performed the following major tasks during a field investigation on November 3 and 4, 2009:

1. Sediment Probing & Impoundment Investigation
2. Bathymetric Survey
3. Sediment Sampling & Analysis
4. Geomorphic Investigation & Identification of Issues Critical to Removal
5. Survey & GPS of Cross-sections Downstream of the Dam and at the mouth of Wills Creek

Weather conditions were clear and flows were normal, corresponding to a daily mean discharge of 553 CFS measured at USGS gage 01603000 (North Branch Potomac River near Cumberland, MD).

Sediment Probing

To estimate sediment quantity, Princeton Hydro staff investigated sediment depths throughout the impoundment with a graduated metal probe. Sediment depths are plotted in the attached aerial photo with sediment probing and sampling locations. As is typical with linear riverine impoundments, sediment deposits were limited to channel margins and point bars of channel meanders. Discernible

throughout the impoundment was a defined thalweg, or deeper part of the channel, maintained by concentrated, continuous flow and lined with compacted gravels and cobbles but with little or no soft sediment. The thalweg in this impoundment is found in the middle of the channel in straight reaches and on the outside of channel meanders. This characteristic is indicative of riverine conditions whereby relatively higher velocities prevent substantial accumulation of sediment. In addition, sediment deposition is further limited by the levee / dike system which prevents flood flows from accessing the floodplain, confining high flows to the channel and increasing sediment transport. The levee / dike system and elevated railroad lines restrict access to the floodplain for nearly 1.3 miles (approximately 7,000 linear feet (LF)) upstream of the dam. Sediment deposits were thickest near the dam and up to approximately 1,000 feet upstream where the channel is widest and deepest. A mid-channel deposit of sediment and woody debris upstream of the central bridge abutment contained over 9 feet of sediment at the time of survey.

The upstream extent of the impoundment was identified by the coincidence of (i) a pronounced increase in velocities at a grade-change / riffle feature (Figure 1), (ii) substrate dominated by gravels and cobbles and completely devoid of soft sediments, and (iii) a narrowing of the channel upstream of the riffle (also apparent in the attached aerial photo). Based on these observations at the time of survey the impoundment is approximately 1.9 miles long (10,000 LF).

Sediment probing results, impoundment delineation and field observations of sediment deposition patterns were combined in an ArcGIS platform to estimate that the entire impoundment contains 140,000 – 190,000 cubic yards (CY) of sediment.

FIGURE 1. Riffle at upstream extent of impoundment approximately 10,000 LF upstream of Cumberland Industrial Dam.

The impoundment was also investigated for general potential issues of concern related to dam removal. Multiple aging industrial buildings are situated adjacent to the channel or in the floodplain but present no significant concerns to dam removal. Several levee drains / stormwater outlets were observed with inverts below the water surface (Figure 2a). Seven small (<12 in. diameter) stormwater outfalls were observed and three larger stormwater outfalls (Figure 2a). None of the outfalls identified are anticipated to be vulnerable to scour or destabilization in the event the dam is removed and water level drops. While the function of levee drain outlets are unlikely to be compromised if the dam is removed, additional consideration may be warranted.

FIGURE 2. Levee drain outlet (a) and stormwater outfall (b) observed approximately 2,000 LF upstream of Cumberland Industrial Dam.

Sediments in the vicinity of the dam are likely to be transported downstream upon removal. In the upstream extent of the impoundment, sediments on the channel margins and inside of meanders are likely to become exposed as water level drops and re-vegetated resulting in stabilization and less transport of sediment.

Sediment Sampling & Testing

On 3 November 2009 three sediment samples were collected from within the dam impoundment pool (DAM) and two locations upstream of the impoundment pool (US1 and US2). Sediment samples were grab-type samples. Sediment samples were analyzed by Test America of Pittsburgh, Pennsylvania for the following parameters: volatile organic compounds (VOC), semi-volatile organic compounds (SVOC), metals, pesticides, polychlorinated biphenyl (PCB) compounds, and dioxin and dioxin-like compounds. Analytical reports produced by the laboratory are appended to this document.

Samples were collected with a Ponar clam-shell sampler or acetate tube sampler depending on water depth and sediment cohesiveness. Areas that were around 10 feet or deeper were sampled with the Ponar clam-shell device. Consolidated sediments in areas 7 feet in depth or less were sampled with the acetate tube.

The sampling equipment was decontaminated between sediment sampling locations so as not to cross contaminate samples. The samples were placed in sterilized bottles as supplied by the laboratory and maintained at a temperature of 4°C within an insulated cooler. Samples for geotechnical analysis were

placed into sealed 2-gallon plastic bags and transported to Princeton Hydro's in-house AASHTO-certified geotechnical laboratory in Sicklerville, New Jersey. Grain size distribution is attached. All three samples were classified as poorly graded sand. A grain size cumulative distribution curve is attached.

VOC were not detected in any of the samples; at least one analyte representative of all other parameters was detected in at least one sample. SVOC, metals, and dioxin/dioxin-like compounds were detected in every sample and each compound class was detected in every sample at concentrations higher than a corresponding ecological screening benchmarks.

Except for dioxin/dioxin-like compounds, detected analyte concentrations were compared to sediment-specific ecological screening values published and/or referenced by USEPA (the site lies in USEPA Region III). Ecological screening values are not remediation criteria; rather they are utilized during ecological risk assessment activities for the purpose of facilitating decision-making. Multiple metals and SVOC were detected in each sediment sample at concentrations higher than the corresponding ecological screening values. One sample exhibited a PCB concentration higher than its corresponding ecological screening value.

Dioxins:

Dioxin and dioxin-like compounds were detected in all sediment samples. The following summary includes Princeton Hydro's suggestions for a forward approach. It is anticipated that additional research on sediment and biotic tissue testing conducted within the Potomac River by others and discussions with Maryland Department of the Environment (MDE) staff regarding the implications of the project-specific initial sediment test results may need to be added to the scope of work for future phases of the Feasibility Study to properly assess the implications of these findings.

Polychlorinated dioxins (CDD) and polychlorinated furans (CDF) and other dioxin-like compounds are formed as by-products in the manufacture of organochlorides, incineration of chlorine-containing substances, paper bleaching, and certain natural sources such as volcano and forest fire. Dioxin and dioxin-like compounds are formed from the thermal breakdown and molecular rearrangement of precursor compounds. Precursor compounds are chlorinated aromatic hydrocarbons having a structural resemblance to the CDD/CDF molecule. Among the precursors that have been identified are polychlorinated biphenyls (PCB), chlorinated phenols (CP), and chlorinated benzenes (CB). [How Dioxins and Furans Form - peer reviewed USEPA draft] EPA/600/6-88/005Ca June 1994 External Review Draft ESTIMATING EXPOSURE TO DIOXIN-LIKE COMPOUNDS VOLUME I: p.13.]

Dioxin and dioxin-like compounds occur ubiquitously in environmental media including biotic tissue. Demonstrated toxic effects of 2,3,7,8-tetrachlorinated dibenzo-*p*-dioxin (2,3,7,8-TCDD) are varied and include impaired reproduction, growth, endocrine function, and survival in a wide range of organisms. Dioxin and dioxin-like substances occur in environmental settings as complex mixtures; exposure assessments are developed in a framework of toxic equivalency comparison. The toxic reference compound for dioxin and dioxin-like substances is 2,3,7,8-TCDD; its mode of action occurs through binding to the aryl hydrocarbon receptor (AHR).

Three sediment samples were collected 3 November 2009 and analyzed for various parameters including dioxin and dioxin-like substances. Dioxin and dioxin-like compounds were detected in all sediment samples. The 2,3,7,8-TCDD (i.e., Dioxin) concentration detected in each sample ranged from 0.57 to 0.93 picograms per gram (pg/g; approximately equivalent to parts per trillion). The USEPA Region III Biological Technical Assistance Group (BTAG) – Freshwater Sediment Screening Benchmark for ecological risk assessment for 2,3,7,8-TCDD is 0.85 pg/g. The sum of dioxin-like compounds detected in sediment samples ranged from 99.5 to 296.6 pg/g.

USEPA (Framework for Application of the Toxicity Equivalence Methodology for Polychlorinated Dioxins, Furans, and Biphenyls in Ecological Risk Assessment, EPA 100/R-08/004, 2008) developed a methodology to assess complex dioxin-like mixtures for ecological risk assessment purposes based on aggregation of the toxicity equivalence concentration (TEC) for each individual dioxin-like substance in a mixture. By this approach, each dioxin-like substance is equated to a toxicity reference value for 2,3,7,8-TCDD (i.e., equivalent to 1); all other dioxin-like substances exhibit TEC between 0 and 1. TEC are calculated separately for different organism classes based on toxicity equivalent factors (TEF) unique to each class. TEC is considered "best" calculated based on dioxin-like concentrations in tissues of organisms at risk; however, TEC frequently is calculated based on dietary concentrations.

Each dioxin-like substance detected was transformed into a TEC and for each sediment sample, individual TEC were summed to generate a sample-based TEC. The aggregate TEC for sediment samples ranged from 4.29 to greater than 50,000. Results are appended to this document. The wide range in calculated TEC is attributable to two factors as follows. For the upper magnitude TEC values, the compound OCDD (octachlorinated dibenzo-*p*-dioxin) is highly toxic to mammals and was detected at comparatively high concentration in two samples (US-1 and US-2) leading to high-end TEC calculations at both samples for the mammalian receptor class. On the lower magnitude TEC, fish are comparatively insensitive to the dioxin-like compounds that were detected and thereby generated low-end TEC values.

Path-Forward Considerations:

The three sediment samples collected to-date exhibited a range of compound detections at concentrations that might present risks to ecological receptors. To better characterize potential ecological risks, additional information may be warranted, including:

- Sediment concentrations up- and down-stream of the impoundment pool to characterize ambient concentrations in the river to include background/reference settings;
- Sediment profile sampling to evaluate the vertical distribution of contaminants;
- Biological tissue concentrations from organism classes at multiple trophic levels (i.e., macroinvertebrates and fish) to assess actual biological uptake and facilitate food-chain exposure modeling;
- Measurement of factors that influence biological availability and fate/transport such as alkalinity of water, total organic carbon content of sediment, and grain size distribution; and/or,
- Biological assessment metrics such as community assemblage information and bioassay bench-scale tests.

While the above-mentioned steps are warranted to achieve a better understanding of potential ecological exposure risks expected due to the project, the Upper Potomac River includes a known dioxin source that was investigated in the late 1980s (i.e., Westvaco paper mill in Luke, MD) and discussions with knowledgeable representatives of MDE regarding the context of dioxin levels detected in the Cumberland sediment sample set are prudent before selecting additional investigation steps.

On 16 July 2010, Princeton Hydro telephoned Dr. Rich Eskin and Mr. Mark Mank, both of MDE and left separate voice messages for each regarding the Cumberland sediment data set results. On 19 July 2010, Mr. Leonard Schugam of MDE Toxics TMDL Technical Development - Science Services

Administration returned Princeton Hydro's telephone messages and requested a copy of the Cumberland project sediment data which was provided. On 27 July 2010, Princeton Hydro inquired as to status of MDE's data review and was informed that Mr. Mank was in the process of reviewing the information. When additional information regarding the MDE review is available, Princeton Hydro will provide a briefing and/or supplemental memorandum, as warranted.

Bathymetric Survey and Geologic Profile

Bathymetric Methods

The bathymetric survey performed on the Potomac River, upstream and downstream of the Industrial Dam, was conducted utilizing two survey methods. The upper impoundment was surveyed with a Knudsen Engineering BP 320 EchoSounder. This sounder uses a dual frequency fathometer to measure both water depth and depth to the bottom of unconsolidated sediment. Locations of the soundings were recorded by a Trimble Pro XH GPS unit, which provided horizontal accuracy of less than a foot. Data was collected by running the sounder perpendicular to the river (shoreline to shoreline) at 50' intervals.

Accuracy of the sounder is dependent on several variables, shallow water depth being one. The mean depth of the downstream survey area was only 2 feet. This depth was not enough to utilize the sounder, and, therefore, this area was surveyed with a calibrated sounding pole. The pole is marked every 0.2 feet. The pole is dropped into the water until it rests on the top of the unconsolidated sediment. The location is recorded with the Trimble GPS unit, and the water depth reading is stored in the GPS point database. The pole is then pushed through the unconsolidated sediment to a point-of-refusal, which constitutes the bottom of the unconsolidated sediment. Again, this depth is stored in the GPS database. As before, data was collected along transects perpendicular to the river, every 25' along the transect.

The water surface elevation (WSEL) was recorded at the beginning of each survey. This was accomplished with a site level and two established benchmarks located in the adjacent train station. This allowed the entire survey to be recorded in the North American Vertical Datum of 1988 (NAVD88).

Once all field work was complete, the data was downloaded to a computer where post processing took place. The calibrated pole data was collected with the Trimble GPS unit. The GPS utilizes a real-time correction unit to gain the highest accuracy achievable in the field. Back in the office, the GPS data is corrected again (Differential Correction), this time with Base Station files obtained from reference sites local to the area. This ensures the highest accuracy achievable with the GPS unit. Once Differential Correction is complete, the data is exported to a comma delimited text file format, where it can be imported into a GIS program.

The sounder data is post processed as well, utilizing a program called Hypack Max that allows the viewing of the raw sounder data. Due to various factors, a small amount of "noise" may be introduced into the soundings. Hypack Max allows for this noise to be identified and eliminated from the final data set. As with the calibrated sounding pole/GPS data, once the sounder data has been post processed, it is exported to a comma delimited text file format, where it is combined with the GPS data to produce one final file of all data collected. This final file is imported into a GIS program where the data can be modeled.

Princeton Hydro utilizes ESRI's ArcGIS software. With the survey data imported into GIS, 3D models of both the upstream and downstream survey areas are created. Each survey area yields two models:

water depth and bottom of unconsolidated sediment. From the water depth model, contours were created at 1' intervals, and mean depth and volume of water within the survey area are calculated. Finally, both models are contrasted to produce a sediment model, which produces sediment thickness contours and the volume of unconsolidated sediment in the survey area.

Findings of Bathymetric Survey

The bathymetric survey of the impoundment upstream of the dam, while providing adequate data for understanding water depth, the low frequency used to measure sediment thickness did not adequately penetrate the substrate. This lack of penetration was most likely due to the coarseness of material and existence of debris, such as logs and other anthropogenic materials. As a result, alternate methods to determine the potential for sediment thickness for later sediment transport and head-cut analysis were used. First, during the sounding survey, hand probes were used to manually determine sediment thickness. To add to this data as well as corroborate the hand probes, the bedrock elevation model developed as discussed in the geologic section of this report were used to estimate the bottom of unconsolidated materials, which could include both accumulated sediment as well as residual and weathered bedrock and soil.

As a result of the survey it was determined that existing maximum water depth within 1,100 feet upstream of the dam is 14 feet near the dam and is relatively consistent for the 1,100 feet surveyed. Approximately 900 feet upstream of the dam, an anomaly was observed creating the appearance of an outcrop or localized area of significant debris, however, after overlay of the USACE plans from the original dam construction is was determined that this was the location of the pre-existing John Street Bridge which had been demolished shortly after the installation of the newer Blue Bridge. This remnant bridge pier was obviously not completely removed and will be exposed in the event of the removal of the Cumberland Industrial Dam.

The results of the survey downstream of the Cumberland Industrial Dam revealed that the majority of the substrate is comprised of bedrock with localized areas of gravel bars, especially at the confluence of Wills Creek and the North Branch Potomac, as well as a large gravel bar at the inside bend of the river just downstream of the subject dam. When compared to the USACE pre-construction bedrock boring logs, it is apparent that the bedrock in the location downstream of the dam was removed to depths between two (2) and three (3) feet. At the dam, of course to accommodate the spillway plunge pool, the bedrock was excavated to a depth of at least five (5) feet to accommodate the dam structure.

As a result of this analysis, it is our professional opinion that there will be a relatively abrupt elevation difference of at least three (3) feet between the upstream and downstream location of the existing dam. It is anticipated that the plunge (scour) pool would be filled as a result of a dam removal, and therefore, any elevation difference would be provided with a transitional feature to facilitate the passage of resident and migratory fish species.

The results of this bathymetric survey will be used as part of the overall conceptual, preliminary and final designs of the dam removal, if such a course of action is chosen.

Geologic/Bedrock Investigation

The dam is located along the Potomac River at the confluence with Wills Creek at the confluence of West Virginia and Maryland. This is the Valley and Ridge Province at the margin with the Appalachian Plateau Province. The region consists of several types of geologic formations: bedrock and surficial geology.

Bedrock Geology

The bedrock in the vicinity of the site consists of layered sedimentary bedrock of Devonian and Silurian periods of the Paleozoic Era of the Phanerozoic Age. The rocks are about 300 million years in age and are comprised of folded/faulted siltstone, sandstone, shale, and impure limestones/dolostones. In the area of the dam these bedrock units form the Knobly Mountain to the south of the dam.

Immediately below the dam site:

Keyser Limestone (DSk, Lower Devonian and Upper Silurian) – formed as deposition in shallow marine and tidal mud flats this formation is conformably overlying the Tonoloway Formation and underlying the Oriskany Sandstone (Lower Devonian). This formation is comprised of dark gray, thin- to thick-bedded, fine- to coarse-grained calcarenite. The formation tends to be impure with inclusions of nodular limestone, dolomitic limestone, and calcareous shale. Near the top of the formation the deposition contains significant chert. The formation is fossiliferous and contains crinoid columnals, stromatoporoids, brachiopods, and tabulate corals.

Other formations in the vicinity:

Oriskany Sandstone (Do, Lower Devonian) – mapped to the north of the dam site - formed in the deposition of sediments in a marine environment this formation is a quartz sand calcium carbonate conglomerate. The formation is light- to buff-grey or brown in outcrop and weathers slowly. Thus making it a ridge formation, however rock can be crumbled in hand when weathered and tends to be coarse to fine-grained, partly calcareous, and locally pebbly or conglomeratic. Common brachiopod casts can be observed in exposures. This formation can be mined for industrial production of materials such as glass, and for silica. It is also known as a gas producing formation.

Tonoloway Limestone (Stl, Upper Silurian), mapped to the south of the site – formed by the deposition of sediments in a shallow marine environment this formation is calcisiltite (compacted silt sized calcite). This formation ranges in color from medium-dark-gray to light-yellowish- gray and olive-gray mudstone and shale with interbedded calcisilite; flaggy and thick in section.

Surficial Geology

The bedrock formations are overlain by deposition of quaternary alluvial/colluvial deposits. Two primary units are mapped in the vicinity of the dam structure:

Alluvium (Qa, Holocene) - formed in flats and low areas these deposits consist of river deposited clay, silt, sand, and gravel deposits derived from surrounding bedrock formations. The material is transported along the river and deposited in sections of the water body based on flow velocity and weight of particle.

Terrace (QTt, Holocene, Pleistocene, Tertiary?) - formed in the upper portions of the river corridor and can also be referred to as fluvial terrace deposits. These represent prior limits of floodplain or river ox-bows. In the vicinity of the dam these terrace deposits sit higher (in elevation) than the alluvium.

The geology of this portion of the country (border of Maryland and West Virginia) is known as the Valley and Ridge Province at the base of the Appalachian Plateau Province. The geology is typified by shallow bedrock and steep slopes in the uplands with broad terraces in and around stream and waterways.

The alluvial/terrace formations and deposits are morphologically associated with the historic tendencies of the adjacent water bodies. In this case many of these deposits represent the previous locations of the Potomac River. The mapping of the terrace deposits extends to the outside of the Potomac River bend at this location, indicating a tendency for the River to hair-pin an ox-bow towards the dike/levee system.

Geomorphology

At Keyser, West Virginia, the North Branch Potomac River breaches the ridgeline composed of Devonian Era sedimentary rock and enters the Folded Appalachian Mountains Section of the Ridge and Valley Physiographic Formation. The northwestern-trending valley is delineated by Knobly Mountain on river right and foot hills of Dans Mountain on river left. The channel assumes a low-gradient (<1%), pool-riffle form with moderate sinuosity (1.4 sinuosity ratio) in a broad, unconfined valley (>16 confinement ratio). The North Branch Potomac meanders across the full breadth of this valley, with meanders alternating from valley wall to valley wall. Upstream of the Allegany County Fairgrounds the valley floodplain is nearly 5,000 feet across; in contrast, just downstream of the Allegany County Fairgrounds the valley narrows to approximately 1,600 feet across. As the river approaches Cumberland, MD, the valley becomes constricted due to Haystack Mountain on river left and river incision into the former floodplain over geologic timescales. In Cumberland, the North Branch Potomac, at the confluence with Wills Creek, breaches the Knobly Mountain ridgeline and turns sharply to the south. The channel downstream of Cumberland appears to be straightened and widened, most likely in an effort to expand hydraulic capacity as part of the USACE flood control project. While valley topography would accommodate channel migration at the confluence, the presence of the adjacent urbanized area of Cumberland requires the continued integrity and functioning of the USACE dike system.

Interaction of geologic conditions in the river following dam removal

Once the dam is removed the velocities will increase with a tendency for the hair-pin to elongate. It appears the river has a tendency to oscillate from the base of Knobly Mountain towards Routes 40 and 51 downstream of the dam. This oscillation was likely reduced when the dam was installed as the hydraulic slope was decreased substantially in this area; removal will likely increase the slope in this area and increasing the frequency and amplitude of the oscillations back into the historic unconsolidated deposits of the stream bed.

Dam Structure and Modifications to the North Branch Potomac River

The dam is designed and apparently constructed to bear on the underlying bedrock formations. Although there is significant folding, mapped primary faulting is sparse. Much of the relief in the area is a function of weathering related to the relative hardness of the rocks and the foliations/structure of the rock formations: sandstone formations tend to weather less readily than the surrounding shale and calcitic formations.

Princeton Hydro reviewed the plans prepared by the US Army Corps of Engineers and made available by the City of Cumberland. These plans included the “Local Flood Protection Project, Cumberland, MD and Ridgeley, W.VA, North Branch Potomac River Industrial Dam”(As-Built Drawings), sheets 1 through 13, dated November 7, 1952 and the “Local Flood Protection Project, Cumberland, MD and Ridgeley, W.VA, Channel Improvement, North Branch Potomac River” (As-built drawings), sheets 1 through 34, dated November 1956. These plans were vital in understanding the changes made to the river and potential impacts if the Cumberland Industrial Dam were removed.

It is apparent that the pre-existing C&O Canal Dam located, 280 feet downstream of the present dam Industrial Dam was relocated to allow for more efficient and unobstructed flow from Wills Creek, an

area of the City of Cumberland. A dam was more likely relocated for the primary purpose of maintaining water levels upstream in the North Branch Potomac for the use by industry along the river. As of the date of this report, it is not known if there was any forethought regarding the use of the Cumberland Industrial Dam for rewatering the C&O Canal in the future; which was recently completed for the revitalization of the C&O Canal for the National Park Service. As we understand, the Canal will be used mainly for passive recreation and historic education purposes.

The design and as-built condition of the Cumberland Industrial Dam clearly depict that the river was excavated through bedrock and shifted to the south towards Ridgeley, WV by 20 feet on the Maryland side, and 40 feet on the W.VA side. To understand the reason for this relocation of the river to accommodate the dam, Princeton Hydro mapped the test boring logs provided on the Cumberland Industrial Dam drawings and overlaid the bedrock elevations on existing conditions survey prepared by Princeton Hydro. Cross sections and profiles were also prepared. Based on the results of the bedrock mapping, the top of rock elevations, clearly follow a downward trend from south to north (West Virginia toward Maryland). It was mostly likely as a result of this downward trend that the dam location was moved south to take advantage of the founding of the structure on shallower bedrock. Another compounding reason from locating the dam to the south, was to enable the placement of the levees on the Cumberland, MD side of the river and channelization of Wills Creek. Regardless of the reasoning, to accommodate the new location, the bedrock on the West Virginia side of the dam was excavated down significantly to accommodate the location of the dam, while on the northern side (MD), the channel was mass filled to grade the northern dam abutment up to adjacent upland areas and the levee system.

It is noted that the Johnson Street Bridge which existed on the 1952 USACE plans, was relocated to the present day Blue Bridge site. In fact, as will be discussed below, the center piers of this bridge still exist below the water surface as was discovered during the completed bathymetric survey. Once the dam was complete, the levee system along the North Branch Potomac River and the concrete channelization of Wills Creek was constructed. Although the dam may be founded on limestone or dolostone formations it appears that these tend to be relatively stable with a low probably of forming sinkholes.

Dike/Levee System

Based on our review of the dike/levee system drawings as provided by the USACE, it is likely that the dike/levee system consists of the unconsolidated terrace and alluvium deposits, placed in a controlled and compacted manner. The Channel Improvement Plans provided by the City only included the levee construction downstream of the Industrial dam, however, it can be anticipated that the levees upstream are provided with dumped rip rap to protect against scour and undermining. The actual extent to which the armoring progresses below the water surface is unknown as this time, however, in the event the dam is removed this scour protection can simply be extended to accommodate the lowered water surface elevation.

Historic Assessment

KCI's senior architectural historian coordinated and lead the conference call between the Parks Service, the City of Cumberland, and Maryland Historic Trust (MHT), to determine an appropriate scope of work for future phases of the Cumberland Dam Removal project. KCI then summarized the outcome of this scoping conference call into a letter sent to MHT, the City of Cumberland and Princeton Hydro.

The conference call was conducted on February 25, 2009, focusing on a determination of the appropriate steps required to comply with Section 106 of the National Historic Preservation Act, for the

Cumberland Dam project. Participants in the call included Raquel Ketterman and Kathy McKenney of the City of Cumberland, MO, Lynne Wigfield of the Chesapeake and Ohio (C&O) Canal, Jonathan Sager of the Maryland Historical Trust (MHT), Laura Wildman of Princeton Hydro, Inc., and Margaret Parker of KCI Technologies, Inc.

MHT noted that the next step in the Section 106 process would be to prepare a Determination of Eligibility (DOE) form to document the dam and evaluate whether it is eligible for listing in the National Register of Historic Places (NRHP). If the dam is determined not eligible for the NRHP, then the Section 106 process is complete. If the dam is determined eligible for the NRHP then coordination would be undertaken with the City and agencies providing funding or permits to identify alternatives to avoid the historic property or develop measures to mitigate the adverse effect.

Other historic properties that may be affected by the proposed project include the bridge above the dam and the C&O Canal. The "Blue Bridge," (MIHP No. AL-IV-A-153, SHA No. 0106600), is a 1955 steel tied arch bride that carries MD 942 over the Potomac River. The bridge was determined eligible for listing in the NRHP under Criterion C as a rare example of steel tied-arch construction in Maryland. Engineering investigations are currently underway to assess the feasibility for removing the dam while maintaining the stability of the existing bridge. The Maryland State Highway Administration, who owns and maintains the bridge (with the West Virginia Division of Highways sharing the costs) and has recently developed a historic bridge management plan that includes the bridge, should be consulted when assessing project effects on the bridge.

The C&O Canal (MIHP No. AL-I-B-086), built between 1828 and 1850 to connect Georgetown in the District of Columbia to Cumberland, Maryland, was listed in the NRHP in October 1966. Portions of the canal in the Cumberland area have been restored and rewatered and the impoundment from the Potomac River Industrial Dam provides water for the canal. This initial phase of the feasibility also includes a preliminary investigation to determine the effect of the proposed dam modifications on the pumping station that provides water for the C&O Canal and to investigate alternatives available to maintain the function of the pumping station.

Based on the discussion described above, it is our understanding that documenting the presence or absence of historic properties (resources listed in or determined eligible for listing in the NRHP) would be required to comply with Section 106 for the feasibility study. Because the dam meets the 50-year minimum age criteria for consideration as a historic property and it has not been previously documented or evaluated, the following steps would be undertaken:

- Prepare a DOE form for the Potomac River Industrial Dam to document and evaluate whether the dam is eligible for listing in the NRHP.
- The DOE form will include description of the physical features of the dam, discussion of the history and development of the structure, and evaluation of its integrity and whether it meets NRHP eligibility criteria. The documentation also will include photographs printed and labeled in accordance with MHT standards and 2 copies of the USGS quadrangle illustrating the location of the resource.
- Submit the DOE form and attachments to the MHT for their review and comment.

Additional coordination with MHT and other consulting parties to evaluate the effect of the project on the historic property would be required to complete the Section 106 process in subsequent phases of the proposed project. A scope of work has been prepared by KCI and included in an appendix to this memorandum, such that this work can be completed in a later phase of this project.

Structural Impact to the Blue Bridge

KCI has completed their initial assessment of the structural impacts that dam removal could potentially have on the "Blue Bridge". Their structural engineer's initial findings show that there will be no impacts to the bridge if the dam were to be removed.

According to Maryland State Highway Administration's (SHA) bridge inventory, Bridge No. 1066 (the "Blue Bridge") is a two-span steel tied arch bridge on MD 932 over the Potomac River built in 1954. Both spans are 156' (+/-) long. The substructure units are all reinforced concrete and are unique in that they are centered on an industrial dam which is 23' (+/-) below the top of pier. The abutments are full cantilevered gravity type abutments with wing walls and a front tapered face. The central pier is a solid shaft with matching tapered faces. According to the design plans the bridge is founded on rock. The bridge is named the "Blue Bridge" because it was reportedly the only bridge in Maryland for years that was painted blue.

The substructure plans for the bridge are not on record at SHA, but details can be found on the as-built industrial dam plans dated November 7, 1952 prepared by the U.S. Army Corps of Engineers. According to the as-built plans, the bridge substructures were built first and then the overflow dam and stilling basin were cast against them separated by a ¾" pre-molded expansion joint. The only thing physically connecting the overflow dam and the substructures is a rubber water stop which is a non-structural membrane used to form a water tight seal between two units. The overflow dam is composed of unreinforced concrete and the stilling basin is composed of reinforced concrete anchored into the rock foundation with 1 1/8" diameter rods placed inside 2" diameter grouted holes; these anchors are essentially what hold the dam in place.

If the dam were to be removed, there would be little or no structural impact to the existing bridge, since basically the two structures were built separately and structurally independent of each other. The dam can be removed at the expansion joint that was constructed between itself and the bridge abutments and pier. It is suggested that as little of the dam be removed as necessary in order to limit excavation around the abutments and pier.

Chesapeake & Ohio Canal Pumping Station

An assessment of the C&O Canal Pumping Station provided by GPM Associates is attached to this document. The assessment includes impacts to the pumping station upon dam removal and suggestions for remedial actions. Follow-up comments on the proposed alternatives were provided by the USACE and are also attached.

Fisheries & Species of Special Concern

The following species are known to occur in/near the Potomac River and its tributaries in the vicinity of the Cumberland Dam:

*American eel	Fallfish	**Rainbow Trout
Blacknose Dace	Fantail Darter	Redbreasted Sunfish
Bluegill	Fathead Minnow	River Chub
Bluntnose Minnow	Golden Redhorse	Rockbass
**Brook Trout	Golden Shiner	Rosysided Dace
Brown Bullhead	Green Sunfish	**Smallmouth Bass
**Brown Trout	Greenside Darter	Spotfin Shiner
Central Stoneroller	**Largemouth Bass	Spottail Shiner
**Channel Catfish	Longnose Dace	Tessallated Darter
Comely Shiner	Mottled Sculpin	**Tiger Muskie
Carp	Northern Hogsucker	**Walleye
Creek Chub	Potomac Sculpin	White Sucker
**Cutthroat Trout	Pumpkinseed	Yellow Bullhead

*Diadromous Species

**Game Fish

Sources:

- Maryland Department of Natural Resources – Maryland Biological Stream Survey
- Maryland Department of Natural Resources – Fisheries Service

Maryland DNR reports that the primary species to benefit from the removal are American eel, walleye and smallmouth bass. Maryland DNR also reports that no species of special concern are found in the impoundment or adjacent reaches.

Water Supply for Firefighting (prepared by City of Cumberland)

Maryland Department of the Environment (MDE) reports that there are three water appropriation permits for the area of the Potomac River around the study location. Two of the appropriations permits exist within the study location. One permit is for the water pump supplying water to the C&O Canal re-watering project. Another permit identifies three areas including the study area and is for the City of Cumberland to make temporary withdraws. More information regarding this permit is that it is limited

at 2,800 gpd average with a maximum withdraw of 40,000 gpd and it identifies two withdraw locations outside of the study area.

Another water appropriation permit is for a location over 1 mile upstream of the" riffles" at 2.7 miles upstream of the Potomac Industrial Dam. The use of this water withdrawal is for ball field watering at the Allegany County Fairgrounds.

The list of identified permits is as follows:

Permit #	Location Identifier
AL2004S001	Withdrawal to re-water the C&O Canal the withdrawal point is below the dam
AL2003S001	For temporary withdrawals by the City of Cumberland at three locations: from Wills creek, the Potomac below the dam, and within the study area (2,800 gpd average, 40,000 gpd maximum)
AL2000S002	Withdrawal from the Potomac for watering ball fields at the fairgrounds which is upstream of the riffles (3.80 miles upstream of the Potomac Industrial Dam)

None of the above permits are used for firefighting. The withdrawals by the City of Cumberland are conducted utilizing firefighting equipment, by which the withdrawal location/depth can be variable depending on river conditions.

The West Virginia Department of Environmental Protection (WV DEP) reports no water appropriations permits of withdrawal from the Potomac River since it is owned by the State of Maryland. Additionally there is only ground water withdrawal recorded within Mineral County WV within the vicinity of the study area. WV DEP staff state that the impact on ground water within the study location should be considered moving forward with the project; however, it is expected that there will be no impact due to size of dam structure and impoundment.

Mineral County 911 Center reports that there is no use of the waters of the Potomac River for firefighting purposes for local jurisdictions within the vicinity of the study area.

Socio-Economic Considerations (prepared by City of Cumberland)

There are a variety of plans and agencies to consult in regards to socio-economic issues when considering removal of the Potomac Industrial Dam under the Blue Bridge (MD Route 942) in Cumberland, Maryland. Impacts and outcomes of the removal of the dam can be positive or neutral as related to comprehensive economic development and tourism planning for the City of Cumberland. Pursuing dam removal is supported by a planning committee organized by the Allegany County Chamber of Commerce. Comments have been received by the general public by way of the Potomac River Project and local media resources.

River Visioning "Potomac River Project"

> In 2009 the Allegany County Chamber of Commerce hosted a series of meetings to generate a prospective on Potomac River Visioning. Over 30 community stakeholders including government agencies, community members, educational institutions, and commercial entities came together for a facilitated river vision brainstorming session. By the end of the session, five key goals were identified and workgroup committees were formed. The committees include: Clean-it, Environmental Learning Center, River Walk Planning, Boating Access, and Dam Removal. A steering committee was developed with appointed leaders from each committee.

Through the Potomac River Project steering committee a variety of community aspects were identified to benefit from the removal of the Potomac Industrial Dam. The potential addition of an enhanced recreational resource near the City's downtown and tourist area is one aspect. With a potentially free flowing channel (between the two flood levees), there is the ability to develop up to two boating access points within the vicinity of downtown Cumberland. Additionally, boaters could safely navigate the seven miles of river between existing boat ramps at the Allegany County Fair Grounds and Cumberland's Mason Sports Complex.

Dam Removal in Relation to Local Planning

The City of Cumberland is no stranger to recreation activity, currently hosting the beginning and end of two regional bike trails. Residents and visitors have the ability to bicycle from Cumberland, Maryland to either Washington D.C. by way of the C&O Canal Towpath, or to Pittsburgh, PA by way of the Great Allegheny Passage. The addition of a new recreational resource adjacent to downtown Cumberland is viewed by the City's Economic Development and Planning offices as a positive opportunity.

City of Cumberland Comprehensive Plan

By restoring the natural channel within the existing flood levee system, natural ecological function and fish passage will be enhanced. The dam removal including restorative activities is consistent with goals within the City's Comprehensive Plan. Provided the removal is a collaborative effort with Maryland Department of Natural Resources (DNR) and U.S. Army Corps of Engineers (USACE), and includes restoring natural habitat and improving recreational access to the Potomac River, the project is supported through the Comprehensive Plan's chapter on Sensitive Areas.

Furthermore, to be consistent with the City's Comprehensive Plan Concept and Transportation chapters, the Potomac River Project and initiatives should be coordinated with the dam removal study process to identify adverse or positive affects by dam removal on the river walk and boating access planning goals.

Sustainable Economic Development Plan

It is a goal of the City's Economic Development Plan to establish Cumberland as a leader in rehabilitation of the built environment and Allegany County as a leader in restoration of the natural environment. By removing the Potomac Industrial Dam and restoring the channel, this project complements the major Strategic Direction #4: Restoration within the Plan: To promote economic activity while sustaining natural capitol by the measurement of environmental (natural and historic) resource preservation.

By participating in and partnering with various agencies on the Chamber's Potomac River Project, the City is working to establish the Allegany County area as a leader in environmental restoration, research, and application of the principles of sustainability. The various committees of the Potomac River Project include the goal of enhancing the scenic area around the Potomac Industrial Dam to attract more residents and tourists, increase passive and active recreation, and encourage redevelopment interest within underutilized facilities within the existing dam location, the City of Cumberland, and the entire region.

Canal Place Heritage Area Plan Update

There are a variety of specific actions within the Canal Place Heritage Area Plan that can be addressed by the removal of the Potomac Industrial Dam. Specifically those activities are related to

opportunities that may arise as a result of the absence of the barrier. Boating and fishing can be enhanced by the increase navigable area of the Potomac at the City of Cumberland. By introducing new access points within the Potomac River in Cumberland there is enhanced opportunity for educational programs that are linked to nature tourism. Improved attraction for local and regional populations could lead to increased use of the Canal Place Festival Grounds, as well as the potential increase in retail development at the Shops at Canal Place.

General Community Comments and Concerns

Common concerns have been raised through a variety of venues including local government plan review meetings, participation in the Potomac River Project, and the local media. Concerns include (i) the potential to increase flooding, (ii) the potential to impact existing historic structures and historic tourism, and (iii) the expense to the community. In these same venues, common positive outcomes have been noted regarding removing the Potomac Industrial Dam. Of the opportunities within a free flowing Potomac River at the dam site, interest in boating access was most frequently noted. Other recreation opportunities identified as part of a River Walk include a walking loop, linking existing and new bike paths, and nature and wildlife viewing. While not all of these activities are directly affected by dam removal, the opportunity to enhance each of these activities is beneficial to the planning of the River Walk and generating interest and maintaining momentum to see the Potomac River Project through from a vision to a destination.

Leaving the Potomac Industrial Dam in place does not negatively impact any of the Plans and most community projects, with the exception of limiting boating access. Impacts from not removing the dam may be felt in the future when dam maintenance becomes an issue and potentially a financial burden to the community. Many proposed improvements consistent with community planning can be pursued whether the dam is in place or not. A general feeling however, is that dam removal could result in increased opportunity of proposed local improvements.

Recreation Opportunities

The removal of Cumberland Industrial Dam removes a safety hazard and boating obstruction while reconnecting miles of continuously boatable river. Due to the steep drop and turbulent hydraulic at the base of the dam, the dam poses a hazard to boaters and is impassable, with no means of portaging around due to the high levee walls. In conjunction with ongoing city planning and redevelopment efforts, unique opportunities exist for enhancing access to the river for boating, fishing, and general recreation. All of the following potential opportunities need to respect private property owners; at this time, Princeton Hydro has not formally contacted any private property owners.

The prime location for increasing public access exists at the current maintenance ramp for the C&O Canal pumping station intake at the Blue Bridge. This ramp, which is currently gated and locked by the City of Cumberland, can be adapted for general public access and car-top boat launch. Parking exists under the I-68 over-pass. The ramp width and grade would need to be modified to enable trailered boat launching. This location would be visible and easily accessible from the paved walking paths and gazebo overlooking the Wills Creek confluence.

Additional opportunities for increasing public access are south of downtown Cumberland using existing roads that cross the rail line and C&O Canal and provide access to the trail and lower floodplain. These points are located (i) at the intersection of South Winneow and Canal Parkway (Route 61) on an access road to a powerline station and (ii) at the end of Elizabeth Street along Canal Parkway. A vehicle access road, boat launch and parking area could be accommodated in the floodplain area below the existing

earthen levee. The site would be easily viewed and accessed by bikers and walkers along the C&O Canal towpath.

Another potential access point to the river exists on the West Virginia side of the Potomac. Access over the earthen dike is currently provided at the north end of Blocker Street. Existing mowed paths provide maintenance vehicle access to the water's edge that could be regraded and reinforced to support increased traffic. Ample space exists for a launch and parking lot. Development of such facilities would have to consider current flood control facilities operations as well as policing and traffic issues that may concern the municipality of Ridgeley, West Virginia.

Bridge Street, in Ridgeley, WV may also be modified to increase public access at the river's edge just upstream of the Blue Bridge. The levee and retaining walls could be mounted with a ramp or staircase to provide fishing access or car-top boat access. Space is limited; the steep grade to the river's edge and traffic patterns on Route 28 would need to be considered in developing this location.

Due to the presence of earthen dikes, concrete levee walls, bedrock bluffs, and active railroad lines, potential points of access are very limited upstream of the pumping station maintenance ramp. At one point, Kelly Road runs along the river with the rail line and I-68 corridors situated close behind. At this location, Kelly Road and the earthen dikes could be modified to create a pull-off and boat ramp. Space is limited and road design and traffic patterns would need to be altered to create an access point at this location.

The next upstream potential access point exists on Industrial Park Road. This location is approximately 2.5 miles upstream of Cumberland Industrial Dam and beyond the dam's impoundment. As this area is most likely private business and light industry, private property would need to be acquired from a willing landowner. Properties are adjacent to the river and could be modified to create a launch ramp and associated parking. Existing road crossings along the railroad are limited upstream; the next available area is at the existing launch at the Allegany County Fairgrounds. Finally, access to the levee is possible in the neighborhood on Williams Street, in Ridgeley, WV. Assuming the levee can be ramped, sufficient space exists for a boat launch and parking area on the floodplain inside the existing earthen levee.

Appendices

- **Sediment Investigation: Probing, Sampling, Analytical Results**
- **Bathymetry and Bedrock Geology Mapping**
- **Historic Documentation Proposal**
- **C&O Canal Pumping Station:**
    - **USACE Design Report Excerpt**
    - **Pumping Station Assessment and Alternatives**
    - **USACE Comments on Pumping Station Alternatives**
- **Public Meeting Records**
    - **Attendance List**
    - **Summary of Comments**
    - **Cumberland Times - News Article**