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Comments by Paul A. Rubin July 20, 2016

HydroQuest, hereby provides review comments on consistency of the US Army Corps of Engineers (ACE) project for flood remediation in the Mamaroneck and Sheldrake river basins in the Village of Mamaroneck with policies of the Local Waterfront Revitalization Program (LWRP). This is a consistency review of the ACE revised Consistency Determination that accompanies a letter dated June 6, 2016 to the Department of State, inclusive of potential environmental concerns. The specific subject matter addressed in this letter is:

> F-2016-0092 - Consistency Determination for the Mamaroneck and Sheldrake Rivers Flood Risk Management Project, Village of Mamaroneck, New York

The June 6, 2016 ACE letter and associated material provides the New York State Coastal Management Program Consistency Review Unit with additional information to support the U. S. Army Corps of Engineers, New York District's consistency determination under the Coastal Zone Management Act for the proposed construction of the Mamaroneck and Sheldrake Rivers Flood Risk Management Project in the Village of Mamaroneck, New York.

Comments provided herein are designed to assist the Harbor and Coastal Zone Management Commission (HCZMC) and the Village of Mamaroneck in updating their consistency reviews. Specifically, the Village Manager requested HydroQuest to address non consistent issues within the physical landscape limitations so that the project could be made consistent to the maximum extent practicable. Because non-consistent policy issues remain in the current ACE Alternate 1Z proposal, HydroQuest has considered what practicable cost-effective means may be employed to achieve the overriding project goal of flood reduction. To achieve the results sought by the Village Manager and the HCZMC a new flood mitigation project design is proposed and addressed herein by HydroQuest.

## Background Information & Consideration of Structural Integrity of Bridges

The ACE Alternate 1Z $72 million Flood Risk Management Plan includes much channel modification work on both the Mamaroneck and Sheldrake rivers.

### Channel Work

River modification work planned under ACE Alternate 1Z, if approved, will occur along 1.82 miles of river channel, inclusive of construction of 3 to 17 foot high retaining walls (averaging 8.5 feet in depth), covering some 8,660 feet (1.64 miles) in length. Maximum planned channel cut depth increases would be as follows: Mamaroneck upriver: 2.3 feet, Mamaroneck downriver: 4.2 feet and Sheldrake River: 3.4 feet. Alternative 1Z channel work will deepen the river bed beneath the Metro North and Halstead Avenue bridges by about four feet in order to allow for increased channel capacity needed to convey incident floodwaters. If channel depths are not increased beneath these bridges, it would seem unlikely that construction of a culvert (see paragraph below) upriver of bridge constrictions would have substantial, if any, benefit. Channel deepening beneath these bridges could pose a risk to their structural stability, especially if any scour potential exists. Thousands of bridges have failed as a result of erosional scour around supports. However, Alternate 1Z does call for placement of concrete along the river bottom beneath the Metro North and Halstead Avenue bridges. While concrete bridge supports may reduce scour potential, they are old and may be deteriorating such that Metro North engineers may wish to evaluate risks involved with channel bed deepening.

Planned channel modification along the Sheldrake and Mamaroneck rivers involves lengthy trapezoidal cuts. As stated in the June 6, 2016 report: "*Trapezoidal channel improvements will consist of a natural bed channel with* ***grassy side slopes*** *of one vertical on two and a half horizontal (1:2.5). Concrete retaining walls will be used where space is limited. Removal and replacement of existing retaining walls and utilities will be necessary* ***along the length of the channel****. Several small bridges will be removed and one bridge will be replaced.*" (emphasis added) While these grassy sloped cuts would allow river access, and are an improvement from old school solid cement channel walls depicted below in a Juneau, Alaska photograph, they are not supportive of healthy river environments.

Similarly, substantial quantities of rip rap and concrete will be used as part of Alternative 1Z channel modification actions. As stated, in part, in the June 6, 2016 report: "*Rip rap and concrete was selected to protect the banks of the Mamaroneck and Sheldrake Rivers from erosion. ... Approximately 1,200 linear feet of riprap (i.e.; 13,000 square feet, 600 cubic yards) will be used for the Mamaroneck and Sheldrake Rivers. About 500 feet of riprap will be located roughly 200 feet both upstream and downstream of the N. Barry Ave Extension Bridge over the Mamaroneck River and 700 feet of riprap will be placed at the 90 degree turn in the Sheldrake River located downstream of the Fennimore Rd. Bridge. Also, due to high velocities and structural considerations along the Mamaroneck River from the Station Plaza Bridge to just downstream of the Halstead Ave Bridge, 300 LF of concrete will placed along the bottom of the stream prevent scour under and around the footings of these three bridges. Most bridge footings have existing concrete at the channel bottom. Otherwise the riverbeds will be maintained in a natural state without concrete bottoms.*"

As detailed in the 3-20-16 HydroQuest report, modern river restoration work seeks to incorporate geomorphic principles to the extent practicable so that water quality, ecosystem, recreational and other considerations are maximized. These recommendations are consistent with recommendations put forth by the Westchester County Watershed Advisory Committee (WAC4; Department of Planning) in their January 2001 report titled: *Controlling Polluted Stormwater: A Management Plan for the Sheldrake and Mamaroneck Rivers and Mamaroneck Harbor* (see Policy item 12 below). WAC4 recommended Best Practices for Water Quality including enhancement and restoration of riparian buffers, stabilization of eroding stream banks with vegetation protective of water quality, and the use of natural stream restoration means. The current ACE flood mitigation proposal does not embrace Westchester County's recommended Best Practices for Water Quality protection and is therefore not consistent with LWRP policies and Westchester County Department of Planning recommendations. **Professional river hydrologists** experienced in natural stream restoration methods do not advocate construction of long trapezoidal-shaped river reaches with grassy slopes (or extensive use of rip rap and concrete when other viable options may be preferable). As HydroQuest has discussed previously, the urbanized setting of Mamaroneck presents a challenging setting for river restoration work. For this reason, some four months ago, HydroQuest strongly recommended bringing in Wildland Hydrology for their world-renounced and respected river restoration experience. This recommendation stands now. **The input of multiple engineering firms not well versed in river morphology and assessment and without years of experience in river restoration does NOT present a foundation upon which approval of a $72 million flood mitigation plan should be based.** HydroQuest, again, strongly recommends that the Village of Mamaroneck obtain the consulting expertise of Wildland Hydrology so that important flood mitigation decisions can benefit from river hydrology experts.

### Floodwater Diversion Structure

Alternate 1Z provides a plan designed to alleviate back flooding upriver of identified channel constriction or choke points. Choke points that may contribute to back flooding of river waters down river of Columbus Park include the concrete sluiceway west of the Railroad Bridge, the Metro North Railroad Bridge, the Halstead Avenue Bridge, the Wards Avenue Bridge and the Tompkins Avenue Bridge. Alternate 1Z seeks to reduce overflow pressure caused by sharp bends in the river at Columbus Park to the Metro North Railroad Bridge. To achieve this, the ACE plans to install a culvert beneath the Jefferson Street commuter parking lot that, by design, would shunt some of the river floodwaters directly upriver of the Metro North Railroad Bridge (see photo below). Presumably, the sharp bend between Mamaroneck River and the culvert would be mitigated so that the existing situation is not duplicated. The dimensions of this culvert would be 25 feet wide by 8 feet high and 350 feet long. Visually, this culvert would be similar in dimension to the one illustrated below in the Details of Tunneling Alternative section.

Alternate 1Z would install a culvert beneath the Jefferson Street commuter parking lot that would discharge into Mamaroneck River immediately upstream of the Metro North Railroad Bridge (top left photo) where it would join Sheldrake River flow. This culvert discharge location is just upriver of the arched Metro North Railroad Bridge, with central support, and the Halstead Avenue Bridge (bottom two photos) which substantially contribute to floodwaters back up throughout the Village of Mamaroneck. In the absence of deepening the river channel beneath these bridges (which is planned), no additional channel cross sectional area would be available to convey rapidly flowing floodwaters. Blasting, mining or dredging many feet downward beneath these bridges may destabilize, undermine or otherwise jeopardize their structural integrity. **Metro North engineers may wish to assess this proposal.**

| Policy # | Evaluation |
|---|---|
| 1 | Not Applicable (NA) to flood control project. |
| 2 | Not Consistent. "*It is recognized that the waterfront of the Village of Mamaroneck is an asset which gives the Village its character and value - and that this is a fragile asset vulnerable to destruction by increasing pressures for re-development. The re-development pressures can result in the elimination of water-dependent uses, and that result would be inconsistent with the policies of this program*." (LWRP, page 53) Alteration of waterfront property within the floodplain of the Mamaroneck and Sheldrake rivers, inclusive of their low flow channels, has the potential to degrade the character and value of properties and eliminate water-dependent uses (e.g., recreational activities including swimming, boating and fishing). Flood risk management structures, especially those that channelize long river reaches, would be detrimental to the character and value of the Village. |

"*Most of the river banks currently have some type of retaining wall, rip rap, or other manmade structure protecting the embankments. The constructed retaining walls will be level with the existing landward ground or no higher than 1 foot allowing access to the rivers. This will allow for future recreational development (walkways, fishing areas, etc.) along the riverbank*." (USACE report of June 6, 2016, page 3) Some of the existing retaining walls, while unnatural in appearance and not ideal for maintaining healthy stream ecology and water quality, have blended in with existing development constructed close to river channels, inclusive of shade-providing tree and shrub growth. An example along the Mamaroneck River near Hillside Avenue is presented below:



Any future alteration of river channels should, wherever possible, serve to enhance stream health, recreational opportunities and land values. Examples of historic Army Corps of Engineers flood control - channel alteration project types that should be avoided are presented below:

North Adams, MA. An early example of ACE project work that did not incorporate means of maintaining river health and water quality.

Gold Creek, Juneau AK. Note beveled cement channel walls with almost no vegetative cover (upstream) vs. limited downstream cover on non-cemented portions. (1956 ACE project).

3 NA

4 Possibly Not Consistent. The Project may detract or may adversely affect existing traditional and/or desired anticipated uses, or the economic base of the Mamaroneck Harbor community. As stated in the LWRP: "The continued health of the recreational economy is largely contingent upon implementation of Policy #2." (LWRP, page 53) To the extent that criteria of Policy #2 is not upheld the adjacent harbor community may be impacted.

5 Consistent if project construction is completed in an environmentally sound and heathy manner consistent with discussions and materials provided in the 3-20-16 HydroQuest report.

6 NA

7 Not Consistent. This policy seeks to protect significant coastal fish and wildlife habitats, as identified in the LWRP, such that they shall be protected, preserved, and where practical, restored so as to maintain their viability as habitats. To the extent that degraded Mamaroneck river water (e.g., thermally heated and nutrient poor) mixes with coastal waters this policy in not consistent. As put forth in the 3-20-16 HydroQuest report, any river alteration work should follow modern fluvial geomorphic practices that seek to protect and enhance water quality. The ACE proposal fails to do this.

8 Not Consistent. Dredging of Sheldrake River sediments poses a risk of contaminant entrainment and mixing from the ITT Sealectro Superfund site, as well as heavy metals and pesticides from non-point sources. The Sheldrake River has been designated as an impaired waterway by NYSDEC. Contaminants reaching coastal waters may degrade significant coastal fish and wildlife habitats. Furthermore, river dredging proximal to this site may lower the regional base level which may undermine and destabilize the stream restoration work completed in Columbus Park. Below, HydroQuest proposes a tunnel scenario to mitigate flooding in the Village that does not involve dredging.

9 Not Consistent. The LWRP seeks to: "*Expand recreational use of fish and wildlife resources in coastal areas by increasing access to existing resources, supplementing existing stocks and developing new resources. Such efforts shall be made in a manner which ensures the protection of renewable fish and wildlife resources and considers other activities dependent on them. <u>Explanation:</u> Recreational uses of coastal fish and wildlife resources include fishing, lobstering, bird-watching and nature study, but exclude hunting*." (LWRP, page 56) Large-scale river channelization will adversely impact and will not promote healthy river ecosystems and a recreational-friendly environment (discussed in the 3-20-16 HydroQuest report). Thus, project constructed retaining walls will impede the future expansion of recreational uses.

10 NA

11 Consistent

12 Not Consistent. LWRP POLICY 12 states: "*Activities or development in the coastal area will be undertaken so as to minimize damage to natural resources and property from flooding and erosion by protecting natural protective features. <u>Explanation:</u> Natural protective features …help safeguard coastal lands and property from damage, as well as reduce danger to human life, resulting from flooding and erosion. Excavation of coastal features, improperly designed*

*structures, inadequate site planning, or other similar actions which fail to recognize their high protective values lead to diminishing or destruction of those values. Activities or development in, or in proximity to, natural protective features must ensure that all such adverse effects are minimized."* (LWRP, page 57)

Natural resources include bankfull river channels, their riparian buffers and floodplains. Miles of hard structural channel modification faced or armored with riprap and cement would degrade ecosystems, water quality, and river functions. Alternate 1Z, as currently planned, would **maximize damage** to natural resources and would irreparably harm the environment. Similarly, the design of Alternate 1Z channel structures does not incorporate modern fluvial geomorphic restoration methods. Large-scale river channelization will adversely impact and will not promote healthy river ecosystems and a recreational-friendly environment (discussed in the 3-20-16 HydroQuest report). **I strongly recommend reviewing an article titled Revitalizing Our Concrete Rivers** (http://soilerosiononline.com/article-permalink-194.html). This example article addresses how some factions of the USACE are working to undo long stretches of concrete-lined river channels to achieve their vision of a recreational haven with restored riparian habitat and wetlands, ringed with greenways, bike trails, and hoped for residential and commercial development. This effort, complete with River Revitalization Master Plan and feasibility study, appears to be a 180-degree opposite approach from that be advocated by USACE Mamaroneck project engineers.

Importantly, article recommendations are consistent with recommendations put forth by the Westchester County Watershed Advisory Committee 4 (WAC4; Department of Planning) in their January 2001 report titled: *Controlling Polluted Stormwater: A Management Plan for the Sheldrake and Mamaroneck Rivers and Mamaroneck Harbor* (see pages 9, 80, 81 and 82). WAC4 recommended Best Practices for Water Quality including enhancement and restoration of riparian buffers, stabilization of eroding stream banks with vegetation protective of water quality, and the use of natural stream restoration means. The current ACE flood mitigation proposal does not embrace Westchester County's recommended Best Practices for Water Quality protection and is therefore **not consistent** with LWRP policies and Westchester County Department of Planning recommendations.

Because extensive river channelization work is proposed in the ACE preferred alternative which would conflict with LWRP policies and would be detrimental to the community as a whole (as detailed in the 3-20-16 HydroQuest report), **HydroQuest provides an alternate flood mitigation scenario that will require limited channel modification work while achieving the desired flood reduction. This is detailed below in the section titled: Mamaroneck Flood Reduction - HydroQuest Tunneling Alternative.**

13 Consistent. As designed, the project will control erosion for at least 30 years - **although it will adversely impact ecosystem health, recreational opportunities and land values**. The 6-06-16 USACE report determined that "*The Project design is based on U.S. Army Corps of Engineers (USACE) experience*

*and industry standards for providing long-term flood risk management. ... The construction of this project along with the operations and maintenance ensure the project to perform as designed in perpetuity*." As discussed in detail in the 3-20-16 HydroQuest report, USACE Alternative 1Z perpetuates concrete channelization project concepts advocated long ago while ignoring major advances in fluvial geomorphology and river restoration. Long reaches of concrete channelization, such as those illustrated above in North Adams, MA and Juneau, AK are destructive to stream ecology, recreational opportunities and land values. Members of these example communities are unhappy with ACE river channel degradation. USACE project engineers have ignored advances in river characterization and restoration that other USACE have helped developed (see discussion of this in the 3-20-16 HydroQuest report).

**HydroQuest strongly recommended that the Village of Mamaroneck consult with Dr. David Rosgen of Wildland Hydrology to determine the best course of project advancement supportive of flood reduction and ecosystem protection. This recommendation is again made here.** Few engineering firms have the expertise to advance river restoration work in concert with modern fluvial river restoration techniques.

14 Consistent. While it is likely that construction or reconstruction of erosion protection structures may be undertaken so that there would be no measurable increase in erosion or flooding at the site of such activities or development, or at other locations, river water quality and ecosystem degradation will accompany the loss of recreationally valuable activities. While it is stated that the ACE project design is based on USACE experience and industry standards for providing long-term flood risk management, the reality is that the project design does not conform with other Army Corps engineers geomorphic river restoration publications or modern fluvial restoration designs. The need to follow modern fluvial geomorphic concepts when "restoring" rivers is accented in the 3-20-16 HydroQuest report. Because portions of the Sheldrake and Mamaroneck rivers have achieved a pseudo-healthy state with significant riverside vegetal growth since historic channelization work was conducted, it is better to leave this state intact vs. further degrading water quality and ecosystem health under the proposed ACE flood mitigation plan. To avoid the planned disturbance, HydroQuest proposes a tunnel flood mitigation plan (discussed below).

15 NA

16 NA

17 Not Consistent. Whenever possible, use nonstructural measures to minimize damage to natural resources and property from flooding and erosion. This is discussed at length in the 3-20-16 HydroQuest report. While the June 6, 2016 ACE consistency review report alludes to the construction of sloped grassy banks with planted trees and vegetation along the embankments for erosion control and for aesthetics, NED Plan Alternate 1Z calls for:

Channel modifications, retaining walls, some bridge removal and replacement, a culvert under the railroad parking lot, and trapezoidal cuts along the Mamaroneck and Sheldrake rivers, including approximately 1.82 miles of channel work in the

Mamaroneck and Sheldrake rivers with new riprap and concrete channel retaining walls from 3 to 17 feet in height and 8,660 feet in length.

If there is a revised NED Plan, HydroQuest does not have it for review.

It is questionable as to whether Alternate 1Z planners have demonstrated a specific, workable, means of dealing with all channel constrictions down river of the Mamaroneck/Sheldrake river confluence such that back flooding will no longer occur in the lower Village of Mamaroneck. As such, it is not clear how the "culvert" planned in the railroad parking area will achieve any active flow during times when floodwaters are backed up behind existing and remaining downriver channel constrictions. Furthermore, the planned riprapped and concrete retaining walls will result is increased river velocities, far in excess of Westchester County' and the Village of Mamaroneck's policy of "zero increase".

18 Non Consistent. *LWRP POLICY 18:* ***To safeguard the vital economic, social and environmental interests*** *of the State and the Village of Mamaroneck, proposed major actions in the coastal area must give full consideration to those interests, and to the safeguards which the State and Village have established to protect valuable coastal resource areas.*

*Explanation: Proposed major actions may be undertaken in the coastal area* ***if they will not significantly impair valuable*** *coastal waters and* ***resources****. This policy applies to actions which would* ***affect natural resources*** *identified in this Program, water levels and flows (both saltwater and riverine), and* ***recreation****.*

**Non-consistent issue:** Converting miles of the Mamaroneck and Sheldrake rivers to riprapped and concrete-walled sluiceways will impair and degrade valuable natural resources and will adversely affect fishing and other recreational activities. The many adverse environmental impacts of advancing Alternate 1Z include increased surface runoff, stream power and flow velocity; decreased river capacity to accumulate, store and filter materials; reduced river capacity to assimilate nutrients and pesticides; adverse ecosystem impacts; and increased exposure to solar radiation, weather and temperature extremes. These are among many potential adverse environmental impacts associated with implementation of Alternate 1Z. These impacts and others that are associated with Alternate 1Z river modification, as planned, are listed in a Table provided in Chapter 3 (Table 3.3) of a major 1998 publication titled *Stream corridor restoration: Principles, processes, and practices* and authored by a Federal Interagency Stream Restoration Working Group (FISRWG). Stream hydrology experts and numerous Federal agencies participated in producing this important work including the U.S. Department of Agriculture, U.S. Environmental Protection Agency, Tennessee Valley Authority, Federal Emergency Management Agency, U.S. Department of Commerce, the **U.S. Department of Defense – Army Corps of Engineers**, U.S. Department of Housing and Urban Development, and the U.S. Department of the Interior. The many contributors to this document included:

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The many adverse environmental impacts associated with implementing Alternate 1Z are listed on this 1998 publication table. **This table (3.3 Potential effects of land use activities) should be carefully examined and is provided in the 3-20-16 HydroQuest report as Appendix B. HydroQuest recommends that this table and its related publication material be used as a guide when evaluating project consistency with the LWRP.** There were many U. S. Army Corps of Engineer individuals who contributed to the environmentally healthy material in this publication which is **not at all consistent** with river modification work proposed in Alternate 1Z. An excerpt block from the 1998 publication follows:

**USACE Channel Restoration Design Procedure**

*A systematic design methodology has been developed for use in designing restoration projects that involve channel reconstruction (USACE, WES). The methodology includes use of hydraulic geometry relationships, analytical determination of stable channel dimensions, and a sediment impact assessment. The preferred geometry is a compound channel with a primary channel designed to carry the effective or "channel forming" discharge and an overbank area designed to carry the additional flow for a specified flood discharge. Channel width may be determined by analogy methods, hydraulic geometry predictors, or analytically. Currently under development are hydraulic geometry predictors for various stream types. Once a width is determined for the effective discharge, depth and channel slope are determined analytically by balancing sediment inflow from upstream with sediment transport capacity through the restored channel. Meander wavelength is determined by analogy or hydraulic geometry relationships. Assumption of a sine-generated curve then allows calculation of channel planform. The stability of the channel design is then evaluated for the full range of expected discharges by conducting a sediment impact assessment. Refinements to the design include variation of channel widths at crossings and pools, variable lateral depths in pools, coarsening of the channel bed in riffles, and bank protection.*

19 Not Consistent. This policy seeks to protect, maintain and increase the level and types of access to public water-related recreation resources and facilities. While the project will not impede access to the river for recreational uses, inclusive through Columbus Park, its channelized non-aesthetic constructed retaining walls would make it undesirable for public recreational use. This is further discussed in Policy numbers 2, 12, 13, 14 and 18 above. Additionally, project construction would degrade the river restoration work previously completed in Columbus Park.

20 NA

21 Not Consistent. This policy states that water-dependent and water-enhanced recreation would be encouraged and facilitated, and would be given priority over non-water related uses along the coast. As discussed in Policy numbers 2, 12, 13, 14, 18 and 19 above the proposed ACE plan is not designed to be protective of natural healthy river channels and their riparian corridors, much less be protective of fishing and recreational opportunities. See additional discussion in the 3-20-16 HydroQuest report.

22 NA

23 Not Consistent but unavoidable. This policy seeks to protect, enhance and restore structures, districts, areas or sites that are of significance in the history, architecture, archeology or culture of the State, its communities, or the Nation. The preservation of all such resources in the Village's coastal area is considered desirable, but preservation of historic and cultural resources which have a coastal relationship are recognized as being of special importance.

Advancement of flood mitigation measures may require the removal of historic bridges (Ward Avenue Bridge, Hillside Avenue Bridge) and failing laid stone channel walls. In order to protect lives and property, it may be necessary to document historic structures before their removal. Consideration could be given to rebuilding historic bridges at alternate locations, perhaps within Columbus Park across the Sheldrake River on raised, engineered, bases.

24 NA

25 Consistent. This policy is designed to prevent impairment of scenic resources of statewide significance. Channel modifications are not of statewide significance.

26 NA

27 Not Included.

28 NA

29 Not Included.

30 Consistent. This policy states: Municipal, industrial, and commercial discharge of pollutants, including but not limited to, toxic and hazardous substances, into coastal waters will conform to State and National water quality standards. It does not apply to the proposed ACE project. As proposed, the project would test for and remove any contaminated sediments found. Policy item #8 above further addresses project related dredging.

31 NA This policy states: State coastal area policies and the purposes of this local program, if approved, will be considered while modifying water quality standards; however those waters already overburdened with contaminants will be recognized as being a development constraint.

32 NA

33 Not Consistent. This policy states: Best management practices will be used to ensure the control of stormwater runoff and combined sewer overflows draining into coastal waters. (See Policies 11, 12, 14, and 37.) Explanation: Best management practices include both structural and nonstructural methods of preventing or mitigating these problems which degrade coastal water quality. As discussed previously, the structural means proposed for controlling stormwater runoff are antiquated and fail to incorporate modern river restoration technology.

34 NA This policy states: Discharge of waste materials from vessels into coastal waters will be limited so as to protect significant fish and wildlife habitats, recreational areas and water supply areas. It does not apply to the proposed ACE project.

35 NA This policy states: Dredging and dredge spoil disposal in coastal waters will be undertaken in a manner that meets existing State and Federal dredging permit requirements, and protects significant fish and wildlife habitats, scenic resources, natural protective features, important agricultural lands, and wetlands. It does not apply to the proposed ACE project.

36 NA This policy states: Activities related to the shipment and storage of petroleum and other hazardous materials will be conducted in a manner that will prevent or at least minimize spills into coastal waters; all practicable efforts will be undertaken to expedite the cleanup of such discharges; and restitution for damages will be required when these spills occur. It does not apply to the proposed ACE project.

37 Not Consistent. This policy states: Best management practices will be utilized to minimize the nonpoint discharge of excess nutrients, organics, and eroded soils into coastal waters. The ACE plan proposes to follow accepted construction practices which are not consistent Westchester County's Watershed Advisory Committee's best management practice recommendations designed to protect water quality. This issue is further addressed in Policy #12 above.

38 Non Consistent. This policy states: The quality and quantity of surface water and groundwater supplies will be conserved and protected, particularly where such waters constitute the primary or sole source of water supply. As detailed in the 3-20-16 HydroQuest report, the proposed ACE project is not protective of surface water quality, fish populations and ecosystem health.

39 Consistent. This policy states: The transport, storage, treatment and disposal of solid wastes, particularly hazardous wastes, within coastal areas will be conducted in such a manner so as to protect groundwater and surface water supplies, significant fish and wildlife habitats, recreation areas, important agricultural land and scenic resources.

40 NA

41 Not Included.

42 Not Included.

43 Not Included.

44 Not Consistent. This policy states: Preserve and protect tidal and freshwater wetlands and preserve the benefits derived from these areas. As designed, the ACE project is likely to degrade or remove the wetland situated northeast of Columbus Park. This policy is intended to preserve and protect the Village's wetlands to the maximum extent possible.

**Background and Flood Mitigation Project Importance (from 3-20-16 HydroQuest report)**

Flood risk, flood damage and public safety have been issues in the Village of Mamaroneck since at least 1877 when a flood event was recorded. They remain major issues today. An historic map of the Village documents that the Railroad Bridge and Halstead Avenue Bridge were constructed on or before 1868. Assorted studies have been conducted through time, all of which document that channel constrictions at bridges situated downriver of the confluence of the Sheldrake and Mamaroneck rivers have resulted in back flooding upriver of constriction points (e.g., ACE, Furey Engineering, Leonard Jackson Associates, HydroQuest).

Without question, flood mitigation work in the Village of Mamaroneck is needed. The issue at hand is how to best achieve flood reduction. It is important that the flood mitigation project that is advanced fully considers 1) all possible alternative remedial/restoration options with emphasis on consistency with LWRP policies, and 2) whether the alternative advanced will actually reduce floodwater impacts. It is important to recognize that, in places, adverse flood impacts are compounded because floodwaters back flooded upriver of the Halstead Avenue area bottleneck become elevated above more normal floodwater stages. As a result, river reaches that would, under lower flow conditions, be free-flowing are full and have no capacity to convey floodwaters within their channels. This then leads to overbank flooding into the Village of Mamaroneck.

**Mamaroneck Flood Mitigation - HydroQuest Tunneling Alternative**

HydroQuest has identified numerous issues associated with the ACE-proposed Alternate 1Z flood mitigation proposal that are not consistent with LWRP policies. Many identify adverse environmental issues associated with old school channelization designs that fail to incorporate modern fluvial geomorphic concepts that are protective of water quality, ecosystem health, recreational opportunities, aesthetics and land values. These issues are discussed at length in the 3-20-16 HydroQuest report. It is likely that project construction, as designed, will degrade the existing channelized river that has, in places, "*recovered*" much of its formerly natural vegetation along its banks. Certainly, this recovery is not a geomorphic restoration as envisioned and advanced by professional river hydrologists who specialize in this work. However, this "*recovery*" that has occurred over many decades of time is better than the extensive high riprap and concrete channel retaining walls proposed up to 17 feet in height over 8,660 feet of channel (1.82 miles of channel "*work*"). At this time, areas with failing channel walls should be repaired (HydroQuest Phase IC) until further geomorphic-based channel restoration work is incorporated into any channel modification work that is ultimately deemed necessary for flood mitigation purposes (see Phase II below in the Recommendation section).

**In the absence of a completely revised ACE flood mitigation plan that is "*river and landowner-friendly*" HydroQuest proposes a new alternative flood mitigation plan that largely leaves the existing channel, its banks and hydraulic gradient undisturbed. This plan advocates using a non-invasive means of flood control as an alternative to ACE proposed large-scale river manipulation. This HydroQuest plans calls for the construction**

**of a large tunnel designed to convey high volume floodwaters down river of existing urban channel constrictions. This tunnel is intended to reduce river flood flows now flowing within the existing channel.** Tunnel boring would be conducted through use of a sophisticated tunnel boring machine. Tunnel location, size and general design are detailed on the GIS map (Flood Plain and Wetland Boundaries with Tunnel Options) and in the discussion below. Additionally, descriptions of two completed tunnel construction projects are provided that document the utility of tunnels for mitigating floodwater problems, inclusive of construction beneath an active railroad line. This tunneling alternative would be substantially cheaper than the current ACE project proposal. Importantly, as requested by the Village Manager, this tunneling plan addresses non-consistent LWRP policies within existing physical landscape limitations so that the project can be made consistent to the maximum extent practicable. As part of Phase I project work, tunnel construction could be fast-tracked. Additional details are provided below.

**Details of the Tunneling Alternative**

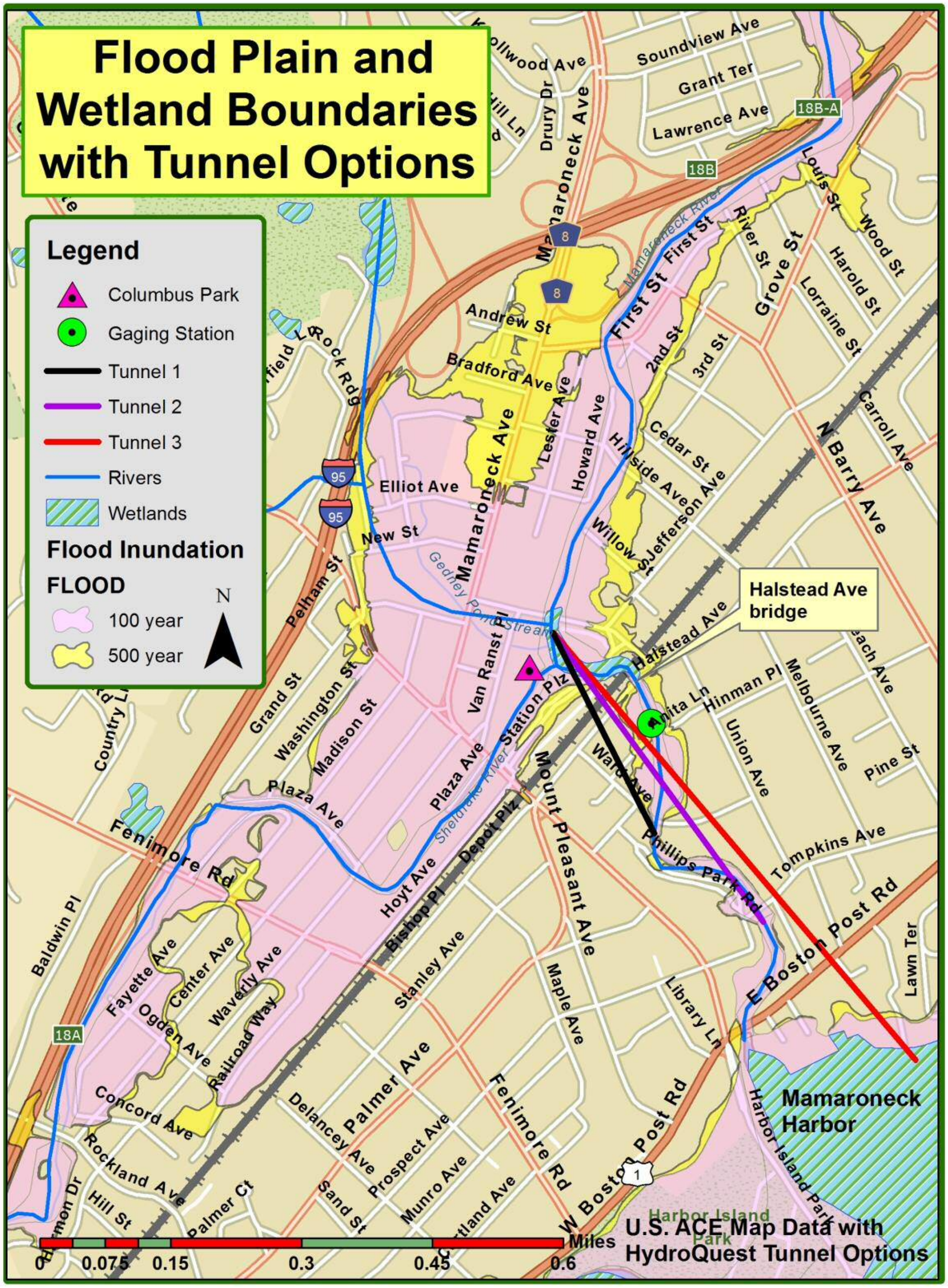
The key issue at hand is the need to eliminate or reduce flooding in the Village of Mamaroneck. As discussed above, flooding has been documented since 1877 and may have occurred earlier coincident with construction of the Railroad and Halstead Avenue bridges (HydroQuest report, 3-20-16). Thus, flooding in Mamaroneck has been a problem for over 139 years. There is no doubt that adverse flood impacts have been compounded by homes and businesses building nearly to the bankfull edge of the Mamaroneck and Sheldrake rivers - thus leaving little or no floodplain area capable of slowing and temporarily retaining floodwaters. Riprap and channeling material placement along river banks and buildings have served to alter, constrain and sometimes reduce formerly natural floodplains. Unnaturally fast-flowing channelized river waters quickly reach channel constrictions at a number of downriver bridges. At high flows, the cross-sectional areas beneath these bridges can no longer efficiently handle large floodwater volumes. Floodwater maps readily show the lateral extent of flooding behind the Halstead Avenue bridge bottleneck (e.g., see Figure 2, page 8 of the 3-20-16 HydroQuest report). Other bridges downriver of the Halstead Avenue bridge probably also contribute to backflooding upriver of the Halstead Avenue bridge. Cement lining along riverbanks, if constructed, may increase river velocity and back flooding behind inefficient bridge dams.

As documented by HydroQuest (3-20-16 report), floodwaters back up behind the Halstead Avenue bridge to at least 3.06 feet above the base of the large I-beam (see HydroQuest figure of this in 3-20-16 report, page 10). The cross-sectional area of water back flooded against the steel I-beam in the 2007 maximum flood of record was on the order of 136 $ft^2$. The actual area required to convey backed up floodwaters is a function of a number of factors including river discharge, Mannings roughness coefficient, wetted tunnel or pipe perimeter, hydraulic gradient, river velocity and tunnel outlet elevation. For discussion purposes, a rectangular culvert measuring 22 feet wide and 6 feet high is considered (see photo below of a culvert with these dimensions located in Kingston, NY that discharges in the Rondout Creek within tidal influence). The cross-sectional area of this culvert is 132 $ft^2$, approximately half of the area of the constructed stone-walled channel at Hillside Avenue (~230 $ft^2$) and approximately equal to that of floodwaters backed up behind the Halstead Avenue Bridge during the 2007 flood (136 $ft^2$). Tunnels may be arched or circular in cross section depending on the boring technology used. A circular tunnel with a cross-sectional area of 132 $ft^2$ would have a diameter of 13 feet.

A means of efficiently conducting floodwaters beyond existing bridge channel constrictions is needed. Importantly, this means should seek to NOT alter or lower the existing channel bed (i.e., invert) elevation thus potentially leading to undermining of existing riprap and disruption of the existing hydraulic base level and ecosystems that have developed within the existing riprap and laid stone channel wall framework. Furthermore, it may be desirable to minimize channel construction activities proximal to homes and businesses already built nearly up to bankfull river stage elevations. Homeowners and businesses are likely to lend support to a flood reduction strategy that eliminates or greatly reduces impacts to their property.

Herewith, HydroQuest proposes a strategy that may accomplish this with minimal property intrusion. After evaluation, this work can be conducted in one or more phases. The first and most important phase envisioned is the construction of a tunnel designed to convey a large volume of the floodwater to a location downriver of all bridges southeast of the railroad bridge and the laterally expansive (i.e., river damming) railroad bed that was constructed perpendicular to river flow. The length of this tunnel and project cost hinges on what locations downriver of the Halstead Avenue Bridge are either not removed or altered to allow for efficient floodwater flow. If, for example, the tunnel were only needed to extend from the Jefferson Street commuter parking lot (i.e., tunnel start point) past the Ward Avenue Bridge, needed tunnel length would be on the order of 1,370 feet (Tunnel 1 on GIS map below). If the tunnel were to extend past the Tompkins Avenue Bridge, needed tunnel length would be on the order of 2,170 feet (Tunnel 2). If the tunnel were to extend from the Jefferson Street parking lot out into Mamaroneck Harbor, needed tunnel length would be on the order of 3,400 feet (Tunnel 3). A Mamaroneck Harbor tunnel outlet location would allow for deeper tunnel depth and a steeper hydraulic gradient. Channel cross-sectional area available to convey floodwaters after downriver bridge removal or modification will dictate tunnel outlet location if this tunnel strategy is adopted. Significantly, tunnel construction and floodwater diversion will allow for the unimpeded flow of Mamaroneck River waters at upriver locations (e.g., south and north of Hillside Avenue). Thus, overbank flooding that now must occur when all the in-channel water storage is filled due to backflooding behind inefficient bridge dam structures will be made available to convey floodwaters downriver beyond an "*uncorked*" bottleneck.

Tunnel construction initiated at junction of the Mamaroneck River and the Jefferson Street parking lot could be designed without any unnatural alteration of either Sheldrake or Mamaroneck rivers (e.g., channel dredging, channel and/or bank armoring, channel widening, upriver channel modification). The Jefferson Street parking lot location is ideally suited because a tunnel constructed there could effectively conduct much of the Mamaroneck River discharge away from Columbus Park prior to its confluence with Sheldrake River. Thus, river floodwater volume reduction incident to the Halstead Avenue Bridge would be greatly reduced by effectively splitting much of the current floodwater flow between the Railroad bridge cement shoot and a tunnel. This would result in reduced in and out-of-channel floodwater inundation upriver of Columbus Park and, therefore, reduced or no upriver overbank floodwater inundation.


Flood Plain and Wetland Boundaries with Tunnel Options
Legend
Columbus Park
Gaging Station
Tunnel 1
Tunnel 2
Tunnel 3
Rivers
Wetlands
Flood Inundation
FLOOD
100 year
500 year
N
Halstead Ave bridge
Mamaroneck Harbor
0 0.075 0.15 0.3 0.45 0.6 Miles
U.S. ACE Map Data with HydroQuest Tunnel Options

For this splitting of river discharge to function well (i.e., water volume reduction), a carefully engineered tunnel inlet control structure is required. This structure would be constructed directly along the east bank of the Mamaroneck River at a predetermined river stage elevation. For example, the elevation selected might be one foot above a river base flow elevation. A concrete control structure mimicking that constructed at the outlet of the Shandaken Tunnel on the Esopus Creek in the Catskill Mountains (USGS 01362230 Diversion from Schoharie Reservoir). There, a 40 foot wide control structure maintains a desired outflow elevation and is designed to funnel water flow toward its center via a slightly down curving arcuate shape. If constructed, when the Mamaroneck River reaches the predetermined elevation, river discharge would be shunted into the tunnel. Project design should include construction of a few in-channel rock weirs or vanes designed to help direct river water into the tunnel and reduce erosion. The Shandaken Tunnel concrete control structure is depicted below:

This tunnel flood dissipation strategy would focus a significant project funding directly to the back flooding problem that has plagued Mamaroneck for over 100 years. Any additional river modification work could be considered after this flood dissipation tunnel was in place and functioning.

### Tunneling and Microtunneling

Substantial diversion of Mamaroneck River floodwaters is possible via construction of a tunnel of sufficient cross-sectional area to convey storm waters around existing channel bottlenecks. A tunnel strategically placed along the east bank of the Mamaroneck River at the west end of the Jefferson Street parking lot would allow partial river flow diversion to supplement the existing channel. Tunneling technologies capable of large-diameter borehole construction include tunneling, microtunneling, and Direct Pipe. These technologies have rapidly advanced within the last 20 years. Microtunneling and tunneling methods commonly involve the use of Tunnel Boring Machines. Tunneling can also involve conventional hand mining using drilling and blasting techniques.

"Microtunneling is a trenchless construction method. It is used to install pipelines beneath highways, railroads, airport runways, harbors, rivers and environmentally sensitive areas without disturbance to the soils or surface above." (DECAST) Microtunneling is non manned, laser guided remote controlled, continuous pipe jacking. Pipes are jacked (pushed) in sequence from entry shaft to exit shaft. In the words of the Pipe Jacking Association:

> "*Pipe jacking is a technique for installing underground pipelines, ducts and culverts. Powerful hydraulic jacks are used to push specially designed pipes through the ground behind a shield at the same time as excavation is taking place with the shield. The term Microtunneling is used for the diameters 0.45 m to 1.0 m.*" (www.pipejacking.org)

With engineered improvements in equipment, microtunneling technology has expanded bore diameters to at least 118 inches (9.8 feet). Tunneling technology is capable of boring tunnels of much greater diameters - of sufficient diameter to provide floodwater diversion of Mamaroneck River waters.

**Tunneling Project Examples**

Tunneling methods have been successfully used to reduce floodwater and sanitary overflow impacts. A few examples of tunneling projects completed by Super Excavators serve to establish the nature and approximate cost of tunneling (http://superexcavators.com/). The Black River Tunnel project (Attachment 1) constructed a rock tunnel some 5,500 linear feet in length with a 23-ft diameter rib and bored tunnel with a final tunnel inside diameter of 19 feet. The tunnel alignment extended **beneath active rail lines**, a boat launch and a bridge for a 2014 contract value of $20,732,954. - a value well within existing funding opportunities. Depending on assorted hydraulic variables (e.g., Mannings roughness coefficient, hydraulic gradient, wetted perimeter, flow velocity, turbulent flow conditions), a 19-foot diameter tunnel could convey approximately 5,300 $ft^3$/sec of floodwaters, considerably more than the discharge of the August 28, 2011 flood (3,970 $ft^3$/sec). For comparative purposes, a 13-foot diameter tunnel could convey approximately 1,900 $ft^3$/sec of water. This 1,900 $ft^3$/sec value is somewhat less the discharge flowing through the stone-walled channel under channel-full conditions (roughly 2,400 $ft^3$/sec based on an unchecked channel slope of 0.0038 and Manning's n of 0.025 for a natural channel in good condition - calculated using Chezy and Manning's equations). Calculation of [For calculation purposes, a slope of 0.0038 and a Mannings roughness coefficient of 0.014 for unfinished concrete were used.] While these numbers are not exact and would require engineering refinement, it is clear that a sufficiently large-diameter tunnel would free in-channel cross-sections from backed up floodwater and solve Mamaroneck's flood problems by allowing free water conveyance outside the flood zone.

Another Super Excavator project example (CS-32-002B Consolidation of Pogues Run Outfall CSO's #034 & 035) included construction of 1,640 lineal feet of 12-foot inside diameter tunnel using tunnel boring machine (Attachment 2; 2006 Contract Value: $12,429,817.). This project was designed to lower a floodplain and improve water quality. The tunnel went under very urban streets including two of Indianapolis' main East-West corridors. These two examples point out that floodplain lowering is possible via tunnel boring technology - all well within budgetary constraints relative to the Mamaroneck flood control project.

If a sufficiently large-diameter tunnel is constructed as proposed here, it is likely that little or no channel modification work will be needed. Tunnel construction provides a means of effectively subdividing Sheldrake and Mamaroneck river watershed flow between an existing channel and a newly-constructed channel. It is conceivable that project completion and flood abatement can be achieved for less than $30,000,000. - providing a high cost-benefit ratio. Engineering analysis should be conducted to refine the tunneling scenario provided here.

**Recommendations**

The key issue at hand is not one of channel erosion, but instead one of flooding and how to best select and implement a means of mitigating and reducing flooding in the Village of Mamaroneck. As has been identified by HydroQuest, the Army Corps and others - channel constrictions down river of Columbus Park are significant contributors to floodwaters backing up within the Village. Flood reduction must entail the rapid, efficient, discharge of high volumes of water rushing through a heavily urbanized setting. As detailed above, construction of a tunnel provides a ready means of "*opening*" the river bottleneck that has caused flooding for over a century without sacrificing water quality and further compromising what natural vegetative cover has grown up around 1930s channelization project work. While tunnel construction will not resolve all upriver channel issues and will not "*restore*" river channels to their pre-urban stable morphology, it goes directly to the heart of the problem and provides a workable solution. Phase II evaluation work can be advanced as needed with the input of professional river restoration experts.

HydroQuest recommends that the flood mitigation project be reevaluated and reengineered, focusing heavily on four key items:

- Phase IA. Implementation of an alternate means of eliminating or substantially reducing back flooded water throughout Mamaroneck during flood events. Specifically, tunneling and microtunneling options should be evaluated. Under this flood mitigation scenario, Columbus Park and the hydraulic grade of both Sheldrake and Mamaroneck rivers would remain intact. Furthermore, this project phase could be **fast-tracked** in response to the numerous severe flood events that have occurred over the last $139^{+}$ years;

- Phase IB. Redesign, replacement or removal of all bridges that may or do constrict floodwater flow (e.g., Ward Avenue, Tompkins Avenue, Hillside Avenue, Halstead Avenue). Some of this is planned in the current ACE Alternate 1Z project proposal;

Low bridges such as the Hillside Avenue Bridge (left) serve as dams during flooding. They require removal or replacement. Note the shade-providing trees that have grown within the riparian buffer since WPA laid stone wall and bridge construction in 1936.

- Phase IC. Restoration or replacement of existing laid stone walls and channel bank structures that require immediate maintenance; and

- Phase II. Project reevaluation and redesign using concepts of modern fluvial geomorphology and river restoration where practicable within the existing urban setting. The environmental, ecosystem, water quality, land value, aesthetic and recreational concepts advanced in the 3-20-16 HydroQuest report should be factored into project redesign. Pending evaluation of Phases IA and IB, with professional input by Wildland Hydrology river restoration experts, completion of this phase with associated homeowner land and river channel modification may not be required.

# Black River Tunnel

| | | | |
|---|---|---|---|
| LOCATION: | Lorain, Ohio | ARCHITECT/ ENGINEER: | Arcadis |
| OWNER: | The City of Lorain | | Attn: Scott Pearson (614) 888-4953 |
| | Attn: William Donohue, Director of Utilities | | 1900 Polaris Parkway, Suite 200 |
| | (440) 204-2500 | | Columbus, OH  43240 |
| | 200 W. Erie Avenue, Lorain, OH  44052 | | |

PROJECT PROFILE

On January 17th, 2012, the Lorain City Council approved a $53,635,243 contract with Walsh/Super Excavators, Inc., Joint Venture, for the Black River Conveyance & Storage Tunnel Phase 1 (Contract 12.28). The Lorain Black River Tunnel was the result of an Ohio EPA order to address overflows that violated the City's discharge permit.  As a solution, City planners developed a "deep tunnel approach" to eliminate sanitary overflows to the Black River and Lake Erie.


For this project, Super Excavators, Inc. teamed up with Walsh Construction as a Joint Venture (Super Excavators was responsible for completing the tunneling work - $20,732,954 of the total contract of $52,000,243).  Electrical work bid under a separate contract which brings the total construction bid price to $55.4 Million.   Walsh/ Super Excavators constructed approximately 5,500 linear feet of 23-ft diameter rib and bored, two-pass, TBM Rock Tunnel.  The final tunnel is a 19-ft ID, monolithic poured, cast-in-place, concrete lined, storage tunnel that extends approximately 120-feet below ground and along the bank of the Black River.  The TBM was launched from a 36-ft ID, 175-ft deep shaft which will serve as home to the future Pump Station.  The machine reached the 30-ft ID, 115-ft deep receiving shaft on April 29th, 2014.

For the first phase of the project, which was completed in early July 2013, Super Excavators constructed 200 LF of wood lagging / steel ring mechanically excavated starter tunnel.  The starter tunnel, which has a 25'x25' arch, was constructed with an Alpine Road Header attached to an excavator, through hard shale rock.




262.252.3200  |  N59 W14601 BOBOLINK AVENUE  |  MENOMONEE FALLS, WI 53051  |  SUPEREXCAVATORS.COM

# PROJECT PROFILE

The tunnel alignment extends alongside existing active CSX rail lines, active marine shipping terminals, and high tension power transmission lines; it extends beneath active Norfolk and Southern rail lines, and beneath the Lorain Port Authority Boat Launch, Black River Landing Park, and beneath the Erie Avenue Bridge.

The ground conditions consisted of shale rock, with a valley of soft-ground material expected at the end of the drive. Because of the potentially gassy shale and the rib-and-board initial liner, Trolex gas monitors were installed every 500-feet to ensure the safety of the workers. A continuous conveyor with a space-saving J-type vertical conveyor was used to transport the muck to the surface.

In addition to the permanent shafts and concrete lined tunneling work, the contract also includes:
Construction of vortex drop structure located at the Westside of the Black River, across from the City of Lorain Black River Wastewater Treatment Plant; A tunnel dewatering pump station located at the existing Lorain Port Authority Public Boat Launch property (built inside the 178-ft deep x 36' diameter launch shaft – "shaft 1"); a screening facility at the north end; several diversion and connecting chambers; a control building at the pump station; and various connecting sewers and conduits.

TOTAL VALUE OF CONTRACT:
$ 20,732,954

COMPLETION TIMELINE:
AUGUST 2, 2012 - SPRING 2015
(TUNNEL COMPLETED ON MAY 1, 2014)

PERFORMED AS:
JOINT VENTURE - WALSH/SUPER EXCAVATORS JV

# CS-32-002B Consolidation of Pogues Run Outfall CSO's #034 & #035

PROJECT PROFILE

| | | | |
|---|---|---|---|
| LOCATION: | Indianapolis, IN | ARCHITECT OR ENGINEER: | Christopher Burke Engineering |
| OWNER: | City of Indianapolis | ARCHITECT/ENGINEER CONTACT: | Jeremy Morris (317) 266-8000<br>115 W Washington St Ste 1368,<br>Indianapolis, IN 46204 |
| OWNER CONTACT: | Ms. Sandra Shafer (317) 327-4546<br>2150 Martin Luther King Jr. St.,<br>Indianapolis, IN 46202 | | |

This project included design of facilities to capture and consolidate two of Indianapolis' major combined sewer overflows. This project was designed to lower the flood plain and improve water quality on the East Side of Downtown Indianapolis. Super Excavators installed 1,640 lineal feet of 167" O.D. Reinforced Concrete segments with a finished interior diameter 12 feet. The tunnel was constructed using a LOVAT 167SE, 167" diameter EPB (Earth Pressure Balance) TBM (Tunnel Boring Machine). The launch shaft was 69 feet deep and the receiving pits were 40 feet deep. The launch shaft required spiliing above the tunnel to prevent settlement above the TBM. The soils varied from coarse sands to stiff clays. The tie-in to Pogues run required demolition of the existing box culvert, installation of a wet well leading to the new tunnel, and reconstruction of the box culvert to accommodate an overflow rain event. The structural concrete work was quite extensive on this project and was difficult due to the high ground water table. This tunnel went under very urban streets including two of Indianapolis' main East-West corridors. We had great success in preventing settlements given the shallow cover of the tunnel and the sandy soils.


Super Excavators, Inc. received ASCE's award for Indiana "Project of the Year in 2006"

TOTAL VALUE OF CONTRACT:
$12,420,817.00

COMPLETION TIMELINE:
FEBRUARY 15, 2005 TO DECEMBER 28, 2006

COMPLETED AS:
PRIME CONTRACTOR