The following sections provide a summary of the evaluation. The four proposed drop shafts are summarized in Table 2-6, and evaluation details are discussed in a technical memorandum provided in PER Appendix Q.

### Table 2-6 Drop Shaft Evaluation Parameters

<table>
<thead>
<tr>
<th>Shaft Name</th>
<th>General Description</th>
<th>Shaft Depth (ft)</th>
<th>Shaft Finished I.D. (ft)</th>
<th># of Inflow Conduits</th>
<th>Design Flow Rate (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>OCIT-3 Shaft</td>
<td>Northwest corner of Dart and Exchange, in Akron Children’s Hospital parking lot. Receives flow from Rack 16-17 Consolidation Sewer.</td>
<td>137</td>
<td>44</td>
<td>1</td>
<td>720</td>
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<tr>
<td>Rack 16-17 Shaft</td>
<td>Located alongside Ohio Canal, north of Exchange Street. Receives flow from Rack 16-17 Diversion Structure.</td>
<td>41</td>
<td>44</td>
<td>1</td>
<td>720</td>
</tr>
<tr>
<td>OCIT-2 Shaft</td>
<td>West side of S.R. 59. Receives flows from Rack 18 and 19 Consolidation Sewers.</td>
<td>110</td>
<td>40</td>
<td>2</td>
<td>595</td>
</tr>
<tr>
<td>Rack 19 Shaft</td>
<td>East side of S.R. 59 and the Ohio Canal Enclosure. Receives flows from Racks 19, 4, and 37.</td>
<td>67</td>
<td>18</td>
<td>2</td>
<td>120</td>
</tr>
</tbody>
</table>

### Vortex Drop versus Baffle Drop Structures

Vortex drop structures have an established performance history for dropping high flow rates. Vortex drop structures have been used for flow rates more than 4 times larger than the maximum flow rate on OCI Tunnel. However, traditional vortex drop structures utilized in the United States and Canada are designed with a vortex approach channel at the top of the drop to slow the flows and initiate the vortex swirling action. In addition, a deaeration chamber between the vortex drop and the final discharge into the OCI Tunnel would be necessary. Traditionally, deaeration chambers are built in an adit constructed between the drop shaft and the storage tunnel connection. Although deaeration in the OCI Tunnel itself was considered, it was not preferred because it could significantly change the hydraulics and possibly the storage characteristics of the tunnel. Finally, tunnels which utilize vortex drop structures often need a tunnel access shaft separate from the vortex drop shaft.
Baffle drop structures have been used with success in many collection systems. The baffle type drop structure has some distinct advantages over the vortex type in that neither deaeration chambers nor vortex approaches are required. Baffle drops require a simple pipe inlet and exit. This could greatly simplify the connection from surface sewers to the drop shafts and from the shafts to the storage tunnel, and would also reduce the required surface footprint. In addition, they allow for multiple consolidation sewer connections at varying depths.

Design flow rates for this project exceed those which have been typically considered for baffle type structures. The largest known baffle drop structure is presently under construction as part of the Southeast Collector in a region of York, Canada. It was designed to convey 370 MGD, which is approximately half of the flow required for the OCIT-3 Drop Shaft. However, recent modeling of baffle drop structures performed by the Iowa Institute of Hydraulics Research (IIHR) has shown greater flow rates can be conveyed using a combination of larger shafts and shifting of the central dividing wall. Shifting of the wall to an off-center position allows more flow in the larger half while still allowing room for access on the other side of the wall. This allows higher flows than previously designed or modeled for a given shaft size. Baffle drop shaft design relationships resulting from the IIHR modeling now support baffle drop configurations capable of conveying flow as high as 770 MGD, which is slightly higher than the largest flow under consideration for OCI Tunnel consolidation sewer conveyance.

Figure 2-15 shows the OCI Tunnel and consolidation sewer alignments with callouts to each drop shaft and diversion structure.
OCIT-3 Drop Structure

OCIT-3 Drop Structure receives flow from Rack 16-17 Consolidation Sewer. Its design flow rate is 720 MGD and it is located in the Akron Children’s Hospital Parking Lot at the intersection of Exchange and Dart Streets, as shown on Figure 2-16. The picture was taken at the intersection of Dart and Buchtel Streets looking south.

Preliminary sizing of a vortex drop structure for OCIT-3 indicates a drop shaft inside diameter of 8-1/2 feet would be required. The Rack 16-17 Consolidation Sewer connects 45 feet below grade. The consolidation sewer elevation at OCIT-3 is controlled by the Ohio Canal crossing and to satisfy ground cover requirements. Preliminary sizing of the vortex approach channel for OCIT-3 Drop Shaft suggest this structure would be 80 feet long, 14 feet wide, and would be approximately 65 feet below existing grade in soft ground conditions. A deaeration adit would also be constructed in soft ground conditions. Finally, an efficient design could provide cost savings for the City by allowing the drop shaft to be used as the TBM recovery shaft; however, the 8-1/2 foot vortex drop shaft size is much smaller than would be required for TBM recovery.

A baffle drop structure for OCIT-3 would require a 44-foot internal finished diameter shaft and would need to drop flow approximately 92 feet to the tunnel invert. This shaft would serve the dual purpose of TBM retrieval after the OCI Tunnel mining is complete, as well as flow conveyance. A clear diameter of 40 feet or greater is needed for TBM retrieval. This diameter is the same order of magnitude as the required diameter for the baffle drop structure. Therefore, there is efficiency in shaft size, and little to no additional excavation is necessary. In addition to dual shaft use described above, a larger shaft could be easily utilized for surge suppression, if found necessary during final design analyses.

For the reasons described here and further detailed in PER Appendix Q, a baffle drop structure is recommended for the OCIT-3 Drop Shaft. See Drawing 303 in PER Appendix A for drop structure configuration.
Rack 16-17 Drop Structure

The Rack 16-17 Drop Shaft is designed to convey up to 720 MGD from the Rack 16-17 Diversion Structure. The structure depth is approximately 41 feet. Figure 2-17 shows the Ohio Canal and Canal Park Stadium where the Rack 16-17 Drop Shaft would be sited. The picture was taken from Exchange Street looking east.

Preliminary sizing of a vortex drop structure for this location requires a drop shaft diameter of approximately 8.5 feet; an approach channel and tangential inlet approximately 80 feet long, 14 feet wide and approximately 30 feet below ground surface; a deaeration chamber approximately 120 feet long and a minimum of 18 feet in diameter; and a 4 feet diameter vent pipe.

The vortex drop configuration described above cannot physically be built without increasing the drop depth from 41-feet to at least 50 feet deep to accommodate the necessary geometry. While this could improve other parts of the project, (e.g. the clearance of the Rack 16-17 Consolidation Sewer beneath the Ohio Canal) deep construction of the inlet and deaeration chambers on this small site would be difficult.

Using the 75/25 baffle drop shaft configuration described earlier in this section, the Rack 16-17 drop would require approximately 44-foot finished inner diameter shaft. Selecting the baffle drop shaft would greatly reduce the required surface footprint on this potentially congested site.
For the reasons described here and further detailed in PER Appendix Q, a baffle drop structure is recommended for the Rack 16-17 Drop Shaft; however, due to the limited drop depth required at this location, the Final Designer may wish to consider modeling of other limited-depth drop configurations such as an enclosed rectangular stepped spillway. Careful consideration should be given to a number of factors, including but not limited to energy dissipation, odor, and ventilation when considering drop structure configuration with unknown or unproven success.

Figure 2-17  Rack 16-17 Drop Shaft Location (Looking East)

OCIT-2 Drop Structure

Two flow inputs are proposed to contribute a combined design flow rate of 595 MGD to the OCI Tunnel in the OCIT-2 area: Rack 18 Consolidation Sewer and Rack 19 Consolidation Sewer. The Rack 18 Consolidation Sewer conveys a design peak flow rate of 475 MGD and Rack 19 Consolidation Sewer design peak flow rate is approximately 120 MGD. Figure 2-18 shows the OCIT-2 area. The picture was taken from the intersection of Glendale and Rand Streets looking north.

The two flow inputs reach the OCIT-2 Drop Shaft at elevations greater than 20 feet apart. Typically, vortex drop structures are used for dropping a single flow source from one elevation. Utilizing a vortex drop structure for OCIT-2 shaft would require two shafts, each having its own approach channel, tangential inlet, and deaeration chamber to drop each flow input separately.
A baffle drop structure at OCIT-2 would be able to accept flow from both consolidation sewers in a single shaft. The baffle drop structure would require an approximate internal diameter of 40 feet to convey the combined peak flow.

Constructing two separate vortex drop shafts and ancillary components for proper functionality would likely be cost and space prohibitive compared to a single baffle drop structure. Even if the Rack 19 Consolidation Sewer were directed into the OCI Tunnel directly, the Rack 18 Consolidation Sewer is still deep enough to make a vortex structure and appurtenant structures expensive to build and maintain. For this primary reason and others detailed in PER Appendix Q, a baffle drop structure is recommended for the OCIT-2 Drop Shaft.

**Figure 2-18  OCIT-2 Drop Shaft (Looking North)**

**Rack 19 Drop Structure**

The Rack 19 Drop Shaft is designed to convey 120 MGD from two inflow points at different elevations; Rack 19 Diversion Structure (Elevation 900) and OCI for Rack 4 and 37 flows (Elevation 877). In addition, the Rack 19 Drop Shaft is likely to also serve as a temporary construction shaft for the Rack 19 Consolidation Sewer, proposed to cross beneath S.R. 59 and ultimately provide access to the tunnel. Figure 2-19 shows the Rack 19 Drop Shaft area on the east side of S.R. 59. The picture was taken from Rand Street looking east across S.R. 59.
Similar to the OCIT-2 drop structure, a vortex drop design at Rack 19 would require two separate drop shafts, with the required appurtenant inlet and deaeration chambers. Conversely, baffle drop structures have been modeled, constructed, and proven to accommodate two separate flow inputs at different elevations. The baffle drop structure would require an approximate internal diameter of 18 feet to convey the design peak flow rates. This drop structure is configured with a 50/50 divider wall configuration.

For the reasons described above, and in PER Appendix Q, a baffle drop structure is recommended for the Rack 19 Drop Shaft.

![Figure 2-19 Rack 19 Drop Shaft Location (Looking East)](image)

**Dry Weather Drop Evaluation**

Drop structure evaluations performed and described above were based primarily upon peak wet weather flows. Conceptual dry weather drop structures were considered for the drop shafts and have been shown on the preliminary design drawings.

In general, the conceptual design includes for each sewer entering a drop structure includes a weir which would encourage flow into a vertical drop pipe built into the invert of the incoming sewer. A grating is shown anchored to the weir and over the drop pipe opening. The grating would help reduce the potential for larger debris entering the system and possibly obstructing the vertical drop pipe.
Dry weather flow would be generally conveyed through the vertical drop pipe to the drop structure base slab and directed to the tunnel by a low flow channel. During a wet weather event, flows should exceed the capacity of the vertical drop pipe, spill over the weir and discharge onto baffles within the drop structure.

The conceptual design shows the top half of the incoming sewers removed inside the drop shaft limits for periodic inspection and cleaning of the grates. However, in the Rack 19 Drop Shaft, the current design indicates one 36-inch diameter consolidation sewer which would enter the shaft below the uppermost baffles. The City would not have direct access to the grating from above, even though this sewer is shown with a weir and grating. The 36-inch sewer would convey flows from the existing Ohio Canal Interceptor into the drop shaft. Upon completion of Racks 4, 16, 17, and 37 modifications, dry weather flows contributing to this sewer would come from existing laterals on the OCI downstream of Rack 17, and the new Rack 4 and 37 dry weather connectors. Rack 37 would have screening at the diversion structure. However, other existing connections contributing flow to this consolidation sewer would be unscreened. It is recommended the Final Designer explore other concepts for this dry weather drop. One option may be to oversize the vertical drop pipe to pass larger debris in lieu of installing grating.

Dry weather drops could be important in these drop shafts to provide for increased odor control, to increase the likelihood of maintaining appropriate scouring velocities, and to further minimize air entrainment. During detailed design, the Final Designer should further investigate and evaluate this and other options for dry weather flow management in the drop shafts.

### 2.10.2 Temporary Earth Retention Systems for Drop Shafts

Feasible temporary earth retention systems (TERS) were evaluated for the large diameter OCIT-3 Drop Shaft, Rack 16-17 Drop Shaft, OCIT-3 Drop Shaft, and Rack 18-19 Drop Shaft. The following sections summarize the evaluation and recommendations. Details of TERS evaluations are presented in a technical memorandum provided in PER Appendix R.

The TERS evaluation began by generalizing the subsurface conditions in the three project areas. Zones in the technical memorandum are referred to as “Northern,” “Midstream,” and “Southern” zones for OCIT-1, OCIT-2, and OCIT-3, respectively. Next, each zone evaluated the preliminary geotechnical data for the feasibility of constructing common TERS listed below:

- Soldier piles with wood lagging and dewatering or ground modification
- Liner plates with circular ribs and dewatering or ground modification
- Drilled secant pile walls with internal wales
- Driven sheet piles
- Slurry walls
- Ground freezing
Shaft TERS for OCIT-3 Area ("Southern Zone")

The OCIT-3 Drop Shaft and Rack 16-17 Drop Shaft areas are characterized by deep soil deposits extending beneath the tunnel invert. Therefore, these shafts are expected to be constructed entirely within soil. The OCIT-3 Drop Shaft is shown in the Preliminary Design drawings as an approximately 50-foot I.D. excavation with a finished floor approximately 137 feet below current ground surface (finished floor Elevation 811). Deep soil deposits are anticipated to include a significant thickness of cohesionless soil and shallow groundwater depths. Construction methods requiring short-term or project-long dewatering activities, such as soldier piles with wood lagging, and liner plates, were deemed undesirable due to the possibility of ground consolidation and/or ground loss from dewatering, combined with proximity of Canal Park Stadium, Ohio Canal, and ODOT bridges on shallow foundation systems. If the dewatering systems were turned off or failed, the bottom of the excavation would become unstable due to the upward gradient of groundwater. In addition, due to the presence of interbedded sand and silt layers, more than one type of dewatering system may be required to effectively dewater these layers (i.e. gravity dewatering in coarse granular soils versus vacuum wells for fine-grained layers). Grain size distribution curves for samples tested in this investigation are presented on Figure 2-5 along with generally applicable dewatering methods (from Construction Dewatering, by J. Powers (1981)).

Final design may consider ground modification in lieu of dewatering. However, stiff, relatively impermeable support systems, such as slurry walls, should be more cost effective and also mitigate risk of settlement and shaft stability. Walls would need to be extended well below shaft invert or the shaft bottom grouted/concreted prior to excavation to prevent bottom instabilities. Secant pile wall methods are unlikely to be feasible for the OCIT-3 Drop Shaft.

Ground freezing may be feasible, but the depth of OCIT-3 shaft and amount of time the shaft would be needed are both areas of concern for the City and Program Management Team.

Finally, regardless of selected TERS, special attention during final design is needed for shaft penetrations required for entry/exit of the TBM or other sewers. Breaching of these soils without proper precautions could result in soil/groundwater flow into the shaft and the risk of large voids, settlement, and sinkholes. Penetrations would most likely require grouting and/or localized dewatering.

Slurry wall TERS is recommended for the OCIT-3 Drop Shaft and for Rack 16-17 Drop Shaft, although other feasible options are available.

Shaft TERS for OCIT-2 Area ("Midstream Zone")

The OCIT-2 area consists of at least two (2) deep shafts. The OCIT-2 Drop Shaft would be located on the west side of S.R. 59, whereas the Rack 19 shaft would be located on the east side of S.R. 59. The OCIT-1 Drop Shaft is shown in the Preliminary Design drawings as an approximately 46-foot I.D. excavation with a finished floor approximately 110 feet below current ground surface (finished floor Elevation 817). The Rack 19 Drop Shaft is shown in the Preliminary Design drawings as an approximately 24-foot I.D.
excavation with a finished floor approximately 67 feet below current ground surface (finished floor Elevation 859).

In general, the area at Rack 19 Drop Shaft is characterized by fill soils ranging from 15 to 45 feet below existing grade, underlain by a relatively thin layer of silts and silty sands over weathered and fresh shales and siltstones. During current and past geotechnical investigations, data identified the presence of course gravels, cobbles, and at least one reported boulder. Groundwater is anticipated to be approximately 30 to 45 feet below the ground surface.

Several feasible construction methods are present for the Rack 19 Drop Shaft TERS, including conventional liner plate and ring beams, and secant piles. Shaft-specific test borings should be investigated during final design to confirm the soil, rock, groundwater, and transitional zone conditions. Depending upon the site-specific results, a drilled shaft concept, such as secant piles, may be advantageous due to its ability to be drilled into competent rock and providing a cut-off through the rock-soil transition zone. Unknown nature of the fill soils and risks that boulders and cobbles could have for drilled shaft construction methods should be evaluated during final design.

The OCIT-2 Drop Shaft would be much larger and deeper than the Rack 19 Drop Shaft. However, the feasible soil and rock TERS are the same types as those applicable for Rack 19 Drop Shaft, except the rock dowel spacing is anticipated to be closer to 5 feet on center.

**Shaft TERS for OCIT-1 Area (“Northern Zone”)**

The OCIT-1 area consists of the OCIT-1 Diversion Structure, the TBM portal launching trench, the Hickory Street Diversion Structure, and several small diameter drop manhole structures. Depths of these structures vary from 20 to 40 feet below existing grade (some structures would be deeper after final site grading is completed). The OCIT-1 Diversion Structure is shown in the Preliminary Design drawings as an approximately 100 foot long by 75 foot wide concrete box structure, with a structural mat foundation bearing approximately 28 feet below current ground surface (bearing at Elevation 792). In general, the subsurface conditions in this area consist of thin fills overlying outwash and lacustrine sands and silty sands, as well as weak organic clays. Based on the preliminary geotechnical soil borings, the bedrock surface can vary from 22 to 54 feet below grade.

Feasible shaft support systems for small diameter shafts are likely to include liner plates with ring beams using localized dewatering systems, or drilled secant piles. The tunnel launch portal trench is likely to be constructed using a combination of ground improvement techniques (e.g. jet grouting) and driven sheet pile cut-off walls. The feasibility of sheet pile walls should be confirmed by a detailed exploration of the bedrock depth along the trench alignment, with special attention paid to the possible presence of cobbles and boulders which would interfere with sheet pile driving.

**2.11 Permits and Coordination**

The Final Designer should be responsible for obtaining permits and performing agency coordination required for construction of their scope of work. Table 2-7 provides a summary of the agencies, permit, and coordination requirements anticipated at the time.
of this report for each proposed contract, and the following sections provide more
detailed information for each agency’s requirements. Permit and agency coordination
requirements could change during final design.

Table 2-7 Permit Requirements / Review Approvals

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Requirements</th>
<th>Contracts Affected</th>
</tr>
</thead>
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<tr>
<td>City of Akron</td>
<td>Grading/Paving &amp; Floodplain Permits, Zoning Approval</td>
<td>OCI Tunnel, OCIT-1CS, OCIT-2CS, OCIT-3CS</td>
</tr>
<tr>
<td>National Park Service (NPS)</td>
<td>ROW Agreement</td>
<td>OCI Tunnel, OCIT-1CS</td>
</tr>
<tr>
<td>Ohio Department of Natural Resources (ODNR)</td>
<td>Plan Review &amp; Coordination</td>
<td>OCI Tunnel, OCIT-1CS, OCIT-2CS, OCIT-3CS</td>
</tr>
<tr>
<td>Ohio Department of Transportation (ODOT)</td>
<td>Plan Review &amp; Coordination, Utility Crossing Permit</td>
<td>OCI Tunnel and OCIT-2CS</td>
</tr>
<tr>
<td>Ohio Environmental Protection Agency (OEPA)</td>
<td>NOI and PTI Permits and Solid Waste Division Plan Review</td>
<td>OCI Tunnel, OCIT-1CS, OCIT-2CS, OCIT-3CS</td>
</tr>
<tr>
<td>Ohio Historic Preservation Office (OHPO)</td>
<td>Plan Review &amp; Coordination</td>
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</tr>
<tr>
<td>Summit County Soil and Water Conservation District (SCSWCD)</td>
<td>Plan Review &amp; Coordination</td>
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</tr>
<tr>
<td>US Army Corps of Engineers (USACE), Buffalo District</td>
<td>Section 10 Permits, Nationwide Permits</td>
<td>OCI Tunnel, OCIT-1CS, OCIT-2CS, OCIT-3CS</td>
</tr>
<tr>
<td>US Fish and Wildlife Service (USFWS)</td>
<td>Plan Review &amp; Coordination</td>
<td>OCI Tunnel and OCIT-1CS</td>
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<td>Utilities</td>
<td>Plan Review &amp; Coordination</td>
<td>OCI Tunnel, OCIT-1CS, OCIT-2CS, OCIT-3CS</td>
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<tr>
<td>Wheeling and Lake Erie Railway Company</td>
<td>Utility Occupancy License, Permit to Enter, if required</td>
<td>OCI Tunnel and OCIT-1</td>
</tr>
</tbody>
</table>

2.11.1 City of Akron

Permit applications would be submitted to the City of Akron to obtain a Grading/Paving Permit, Floodplain Permit, and Zoning Approval. The permit applications would be submitted during detailed design. These permits apply for OCI Tunnel, OCIT-1CS, OCIT-2CS, and OCIT-3CS Contracts. Conditional use approval from the Board of Zoning Appeals is required for OCI Tunnel and OCIT-1CS contracts for permanent above-grade structures.
2.11.2 National Park Service

The National Park Service (NPS) owns the Cuyahoga Valley Scenic Railroad (CVSR), a historic rail line providing service through the Ohio & Erie Canalway and Cuyahoga Valley National Park. At approximately tunnel STA 16+00, the proposed tunnel crosses under the Cuyahoga Valley Scenic Railroad. Permit applications would be submitted during detailed design to obtain a ROW Agreement. Requirements issued by NPS to protect their structures would be incorporated into the bid documents. This agreement would be needed for the OCI Tunnel and OCIT-1CS contracts.

2.11.3 Ohio Department of Natural Resources

The Ohio Department of Natural Resources (ODNR) would review design documents during final design. Requirements issued by ODNR would be incorporated into the bid documents. This coordination would be needed for the OCI Tunnel, OCIT-1CS, OCIT-2CS, and OCIT-3CS contracts.

2.11.4 Ohio Department of Transportation

The OCI Tunnel alignment and OCIT-2CS consolidation sewers are within the limits of Ohio Department of Transportation (ODOT) S.R. 59 and S.R. 18 properties. S.R. 59, also known as the Innerbelt, is a state highway with parallel access roads (Dart Street and Rand Street) providing vehicular access to downtown Akron. The highway and access roads are within Limited Access limits. S.R. 18, also known as West Market Street, is a state road crossing S.R. 59 and is on the National Highway System. West Market Street crosses S.R. 59 via a bridge. The OCI Tunnel alignment generally runs parallel to S.R. 59 except where it crosses from Rand to Dart Streets between tunnel STA 40+00 and STA 59+00.

The City of Akron met with ODOT three times during the preliminary design phase. During a meeting on July 27, 2012, which was attended by both District 4 and ODOT Central Office staff, ODOT gave the City the following feedback on the preliminary design:

1. ODOT had no comments about the tunnel under Rand Street and Dart Streets as those streets are considered City responsibility.

2. The alignment shown to ODOT (OCI Tunnel Alignment 4B-AKR) was acceptable in principle. After the meeting, ODOT issued an email to the City to document this statement.

3. ODOT requested reviews of each design submittal.

4. ODOT was concerned about potential impacts to the bridges adjacent to the OCI Tunnel alignment. They would review and allow monitoring action plans as a mitigation method, provided calculations showing the predicted impact of the tunnel (short and long term) was likely to be minimal.

5. ODOT requires culverts greater than 10 feet in diameter to be designed to support loads as if it was a bridge. This criteria applies for the OCI Tunnel where it crosses S.R. 59. Load cases are detailed in the Ohio Bridge Design Manual.
6. ODOT would work with the City to make necessary site civil improvements for the proposed structures at Racks 18 and 19 near West Market Street and Rack 4.

7. ODOT District 4 indicated the final design review and approval process would require the following process:
   a. ODOT District 4 review of 30, 60, and 90% design submittals.
   b. Resolution of comments between ODOT District 4 and the Final Designer(s) and City.
   c. Utility Crossing Permit issued by ODOT District 4 is required for OCI Tunnel and OCIT-2CS contracts.
   d. No objections letter issued by ODOT District 4 is required.
   e. Federal and/or Central Office approval is not required.

2.11.5 Ohio Environmental Protection Agency

Permit applications would be submitted to Ohio Environmental Protection Agency (OEPA) to obtain a Permit-to-Install (PTI), Notice of Intent (NOI), and Stormwater Pollution Prevention Plan (SWPPP). The permit applications would be submitted during detailed design and involve coordination with the Northeast District Office (NEDO) and Division of Environmental and Financial Assistance (DEFA). A PTI is required for the proposed sanitary sewer structures and water main relocation(s). The Final Designer would develop a proposed SWPPP, and the contractor would be responsible for modifying the SWPPP to meet their actual means and methods, if different than designed. A 401 Water Quality Certification may be required, if determined during final design. OEPA Permits would be needed for the OCI Tunnel, OCIT-1CS, OCIT-2CS, and OCIT-3CS contracts.

Work within 300 feet of the dump area near the St. Vincent St. Mary football field would require coordination with OEPA Solid Waste Division. The Final Designer should coordinate with the City and OEPA for review of plans and specifications in this area.

2.11.6 Ohio Historic Preservation Office

Ohio Historic Preservation Office (OHPO) would review design documents during final design. OHPO would issue a No Adverse Effects Letter or would require mitigation measures to protect identified structures. Requirements issued by OHPO would be incorporated into the bid documents. The Final Designers would coordinate with OHPO for the OCI Tunnel, OCIT-1CS, OCIT-2CS, and OCIT-3CS contracts.

During the preliminary design, a records search and a Phase 1 History and Architecture field survey was conducted for a corridor 350 feet wide, centered on the OCI Tunnel. The findings are discussed in Section 2.15 and provided in PER Appendix G and PER Appendix H. A Project Summary Form, included in PER Appendix H, would be submitted to OHPO by the City.
2.11.7 Summit County Soil and Water Conservation District

Summit County Soil and Water Conservation District (SCSWCD) would review the Storm Water Pollution Prevention Plan (SWPPP) during final design and issue a Letter of Approval. Requirements issued by Summit County SWCD would be incorporated into the bid documents. The Final Designer should be responsible for SWPPP submission.

2.11.8 US Army Corps of Engineers, Buffalo District

Permit applications would be submitted to USACE, Buffalo District for construction activities near surface waters. The Ohio Canal, classified as a navigable water, and the Little Cuyahoga River is within the construction work areas. A wetland delineation was performed in the areas adjacent to the Little Cuyahoga River and no Federal jurisdictional or State isolated wetlands were found, with the exception of the river itself. Additional information on the wetland delineation performed is discussed in Section 2.14. For construction activities near and under these water bodies, US Section 10 (Rivers and Harbors Act) and Nationwide Permits have been identified, as described in Table 2-8. The permit applications would be submitted during detailed design. Requirements issued by USACE would be incorporated into the bid documents.

Table 2-8 USACE Required Permits

<table>
<thead>
<tr>
<th>Permitted Area</th>
<th>Contract</th>
<th>Required Permit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rack 16-17 Consolidation Sewer</td>
<td>OCIT-3CS</td>
<td>Section 10</td>
</tr>
<tr>
<td>Rack 16-17 Outfall Modifications</td>
<td>OCIT-3CS</td>
<td>Nationwide Permit and Section 10</td>
</tr>
<tr>
<td>Racks 18/19 Consolidation Sewer</td>
<td>OCIT-2CS</td>
<td>Section 10</td>
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<tr>
<td>Tunnel Overflow &amp; Little Cuyahoga Bridge Crossing:</td>
<td>OCI Tunnel, OCIT-1CS</td>
<td>Nationwide Permit and Section 10</td>
</tr>
</tbody>
</table>

2.11.9 US Fish and Wildlife Service (USFWS)

The US Fish and Wildlife Service (USFWS) was contacted during preliminary design to coordinate and determine field investigation requirements, as discussed in PER Appendix T. The USFWS has indicated that Indiana bat endangered species could be within project areas. This concerns the tunnel mining site for OCI Tunnel contract, the consolidation sewer construction area in the OCIT-1CS contract, and staging area for OCIT-1CS. To date, the City has completed field visits and coordinated with USFWS to perform mist netting. Mist net survey results would need to be submitted to USFWS upon completion. Coordination with USFWS would continue through the design, and USFWS would review the design documents during final design. Requirements issued by USFWS would be incorporated into the bid documents.
2.11.10 Utilities

Utilities with facilities within the project limits would review the design documents during final design. Requirements issued by the utilities would be incorporated into the bid documents. Refer to Section 2.12 for further information.

2.11.11 Wheeling and Lake Erie Railway

The OCI Tunnel crosses under a railroad owned by Wheeling and Lake Erie Railway Company at STA 25+20. The tunnel is also within approximately 50 feet laterally of an existing elevated rail bridge which crosses over the Ohio Canal. A permit application would be submitted during detailed design to obtain a Utility Occupancy License and, if required, a Permit to Enter. Requirements issued by Wheeling & Lake Erie Railway Company to protect their structures would be incorporated into the bid documents. A copy of the Permit to Enter can be found on Wheeling & Lake Erie Railway Company’s website at www.wlerwy.com.

2.12 Utility Conflicts

Utility research, coordination, and, if necessary, field location verification of external facilities would be performed during final design. The purpose of research would be to quantify utility relocation costs, modify new sewer alignments if necessary, and identify new properties and/or easements the City may need to acquire to provide for relocation.

The utilities shown on the preliminary design drawings were located in horizontal position only. Utility coordination should be one of the earliest tasks for the Final Designers and should require close coordination during final design in order to prevent relocations from interfering with other new facilities designed by different Final Designers. Table 2-9 lists potential utility conflicts identified within the project limits.

<table>
<thead>
<tr>
<th>Location</th>
<th>Utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main Street</td>
<td>Fiber Optical</td>
</tr>
<tr>
<td>Canal Park Parking Area</td>
<td>Steam Lines</td>
</tr>
<tr>
<td>ACH Parking Lot</td>
<td>Storm Sewer</td>
</tr>
<tr>
<td>Hickory Street</td>
<td>Watermain</td>
</tr>
<tr>
<td>Hickory Street</td>
<td>Sanitary Sewer</td>
</tr>
</tbody>
</table>

Initial utility locations would be further evaluated during the preliminary design phase of the project. Preliminary design drawings would be supplied to the appropriate utility companies within the area to confirm represented information is accurate. The Final Designer would be notified of major utility conflicts not shown on the preliminary design drawings.

2.13 Evaluation of Alternative Technologies

As part of the Preliminary Design, alternate concepts were reviewed for controlling Racks 4, 16, 17, 18, 19, 20, 23, 24, and 37. Some concepts may have the potential to
reduce the CSO Program Costs and still achieve control levels required by the LTCP Update. Some concepts may require construction of the OCI Tunnel as described in this Preliminary Design; some concepts may not. Most concepts would require negotiation with the USEPA and OEPA for a modification to the approved LTCP Update. Concepts should be studied further to determine the optimum combinations. Once the optimum combinations are determined, and if the savings are significant, contact should be made to USEPA and OEPA to begin technical discussions. The alternative technology / alternative concept analysis is advancing in parallel schedule with the final design of the OCI Tunnel project as described in this report and the attached plan drawings.

The concepts evaluated are Vertical Treatment Shafts (VTS) and alternate storage concepts. Treatment Shafts (patented by S. Ghalib and marketed by Applied Engineering Technology) was evaluated to assess the likelihood of using the VTS to replace a future treatment facility to treat overflows from the OCI Tunnel. Alternate storage concepts were also evaluated which may result in downsizing of the OCI Tunnel. The alternate storage concepts consisted of construction of a new storage basin at the end of the OCI Tunnel, oversizing of OCI Tunnel consolidation sewers to gain storage volume, and extending the OCI Tunnel length. These alternate concepts were evaluated at a preliminary level and presented to the City on July 19, 2012. The City provided feedback and, as of the date of this report, particular variations and combination of these concepts are being advanced for an upcoming workshop.

The following sub-sections present a summary of the alternate concepts studied to date. A detailed description of the Vertical Treatment Shaft evaluation is presented in a memorandum included in PER Appendix U.

### 2.13.1 Summary of Vertical Treatment Shaft Concept Evaluation

The VTS is a new hybrid system that provides both storage and primary treatment of flows through the system. The concept was developed within the last decade. The concept was most recently applied to meet wet weather capture and treatment requirements agreed to by the City of Dearborn, Michigan. The VTS shaft system consists of an influent pipe or culvert where the flows are dosed with chlorine. The flows plunge into a single large storage shaft which is divided into two halves by a center divider wall which allows underflow. Flows continue until reaching the bottom of the divider wall. Once the center wall is submerged, floatables in the incoming flow are kept on the upstream side of the wall. The shaft continues to fill until the end of the storm event. The shaft is dewatered to a local interceptor sewer, and sediment or debris left in the bottom of the shaft is re-suspended by a spray system, and then pumped through a chopper pump to the interceptor.

If the storm flows are greater than the storage volume of the tank, the flow is forced under the baffle and then up through horizontal bar screens and out an effluent channel to a receiving waters. Flows discharged from the shaft receive screening, settling in the bottom of the shaft, and chlorine contact time while the flows are passing through the facility. The amount of treatment and solids removal is then related to the flow rate through the facility.

Three concepts using the Vertical Treatment Shafts were analyzed. The concepts were as follows:
• Concept 1 - VTS to replace the entire OCI Tunnel and EHRT facilities
• Concept 2 - VTS plus conveyance tunnel to LCI north of Hickory Street site
• Concept 3 - VTS plus storage tunnel to LCI north of Hickory Street site

**Concept 1 - VTS to replace entire OCI Tunnel and EHRT facilities**

The first concept was to provide VTS storage and treatment at each of the major rack locations to be controlled under this project. Specifically, there would be one shaft near Racks 16 and 17, one shaft near Racks 18 and 19, and one shaft at the current proposed EHRT site between Hickory Street and the Little Cuyahoga River. Each shaft would be sized to store the typical year flows so there would be no CSO discharge to the Canal. Storm events larger than the typical year storms would be screened and treated before discharged into the Ohio Canal or the Little Cuyahoga River. Dry weather flows would continue in the existing Ohio Canal Interceptor (OCI) and the OCI would also be necessary for dewatering of the VTS after rain events.

The total storage required for this concept is 216 million gallons. Based on preliminary calculations, the largest treatment shaft necessary to achieve this concept would be over 200 feet in diameter and over 300 feet deep. There is not sufficient operating data to confirm the shafts would be able to treat the combined sewage to the levels required by the LTCP. However, because of the size of the shafts, there is high likelihood the chlorine contact time would be more than sufficient to meet E. coli and biochemical oxygen demand (BOD) requirements, and solids settlement would be sufficient to meet total suspended solids (TSS) requirements. The concept would require a complete revision of the approved LTCP because no storage tunnels would be built.

This concept was estimated to have the potential to reduce the combined OCI Tunnel and EHRT cost by approximately $80 million. However, this concept was not feasible due to the size of the required shafts and the lack of available land in downtown Akron. In addition, the VTS is considered an “unproven technology” and USEPA and OEPA is unlikely to substitute this technology for the EHRT technology without extended pilot studies, putting the City at significant risk of missing LTCP milestone dates and being subjected to stipulated penalties.

**Concept 2 - VTS plus conveyance tunnel to LCI north of Hickory Street site**

The second concept was similar to the first, except with the addition of a 12-foot I.D. conveyance tunnel from each shaft to the Hickory Street Site. The addition of the conveyance tunnel could allow the City to abandon the OCI, and would allow the City to convey flows to an EHRT site if the VTS did not meet LTCP effluent quality requirements.

This concept is estimated to cost the City of Akron more than the combined cost of the OCI Tunnel and EHRT, and it has the same risks as described above; therefore, this concept was recommended as not feasible.
Concept 3 - VTS plus storage tunnel to LCI north of Hickory Street site

The third VTS concept is to replace only the proposed EHRT facility and some of the tunnel storage with a VTS. The VTS could be sited at the Hickory Site where the EHRT site is currently proposed. The VTS could be designed for a volume of 8 million gallons, which is estimated to be a 97-foot diameter shaft approximately 145 feet deep. The detention time would be approximately 10 minutes. The VTS could provide storage, allowing the OCI Tunnel diameter to be reduced from 27 feet to 22 feet, and could provide treatment for flows exceeding the storage capacity of the system. The level of treatment would vary depending upon the flow rates.

The estimated probable construction cost in 2012 dollars is $266.2 million. This concept was estimated to have the potential to reduce the City’s costs by approximately $20 million in 2012 dollars. However, the VTS is considered an “unproven technology” and USEPA and OEPA is unlikely to substitute this technology for the EHRT technology without extended pilot studies, putting the City at significant risk. If the USEPA and OEPA were to reject the VTS as a treatment facility, the City would have to build the EHRT (estimated at $60 million in 2012 dollars).

This option would be studied further and compared against other concepts (described below). If the cost savings potential were high enough and the City was willing to pilot the facility and take the risk of getting the technology approved, negotiations with USEPA and OEPA should begin immediately. The OCI Tunnel design would proceed with the preliminary design concept at the same time as negotiations.

An alternatives evaluation workshop was held on September 12, 2012 with City representatives to discuss the VTS options. The three VTS alternatives were presented and discussed during the meeting, including potential cost saving for the alternatives. The group decided that the VTS option was too large of a risk to proceed forward with and decided to not pursue further evaluation of alternatives that contain VTS technologies. A memorandum and meeting minutes from this workshop are provided in PER Appendix EE

2.13.2 Summary of Alternate Storage Concepts

The approved LTCP Update states the Control Measure for Racks 4, 16, 17, 18, 19, 20, 23, 24, and 37 is as follows:

“Ohio Canal Tunnel – Construct a 28-foot internal diameter tunnel, 5,550 feet in length, or any other combination of diameter and length that achieves the design criteria.”

The LTCP also states the design criteria for this control measure is as follows:

“Minimum storage volume of 25,600,000 gallons. This volume excludes conveyance tunnels, dewatering tunnels / sewers, adits, and drop shafts.”

Alternate storage concepts for the project were reviewed to determine if there were cost savings substantial enough to justify seeking approval from USEPA and OEPA. The following five (5) general alternate storage concepts were considered:

- Utilizing the EHRT Facility for Storage
• Building a storage tank at the termination of the OCI Tunnel to reduce the OCI Tunnel diameter

• Oversizing the consolidation sewers in the OCI Tunnel system to reduce the OCI Tunnel diameter

• Extended Tunnel Alignment

• Stacked EHRT and Storage Tank

A workshop was held with the City on September 12, 2012 to discuss these alternatives. A memorandum and meeting minute’s form the workshop is provided in PER Appendix EE.

Utilizing the EHRT facility for storage

The EHRT facility is anticipated to be a rectangular tank with a wall height of approximately 27 feet. The EHRT facility is estimated to have a water holding capacity of 2.3 million gallons. This concept requires approval by USEPA and OEP to count this volume as part of the 25.6 million gallon storage requirement. This concept downsizes the OCI Tunnel from approximately 27 feet I.D. to approximately 25.5 feet I.D. The cost savings, primarily in the form of reduced tunnel diameter, is estimated to be approximately $10 million.

In order to accomplish this concept, the EHRT tank design would need to be accelerated so the tank could be constructed at the same time as the OCI Tunnel. The EHRT process equipment could be installed during the OCI Tunnel construction or delayed until the currently scheduled construction date in 2024.

It is recommended the City not pursue this concept because it would require early construction of the EHRT structure. It may result in higher costs for retrofitting the process equipment into the existing tank and the cost savings are less than 10% of the combined OCI Tunnel and EHRT construction cost estimate.

Building a storage basin at the termination of the OCI Tunnel

The storage basin concept involves the construction of a covered storage basin at the downstream end of the OCI Tunnel. The basin would be constructed above grade so CSO storage in the OCI Tunnel and basin could be conveyed by gravity into the LCI, the Little Cuyahoga River, and the future EHRT facility. Based on preliminary layouts for the EHRT facility at the OCI Tunnel mining site and assuming the OCIT-1 Diversion Structure is incorporated into the storage basin, the site could accommodate up to approximately 12 million gallons of storage. As a result of the storage basin, the OCI Tunnel diameter could be reduced.

Several combinations of storage basins and OCI Tunnel sizes were analyzed to meet the approved LTCP volume of 25,600,000 gallons. Table 2-10 illustrates those combinations. This table assumes a tunnel length of 6150 linear feet.
Table 2-10  Tunnel and Storage Basin Sizing Combinations

<table>
<thead>
<tr>
<th>Tunnel Inside Diameter, ft</th>
<th>Tunnel Storage Volume, MG</th>
<th>Required Storage Basin Volume, MG</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>14.1</td>
<td>11.5</td>
</tr>
<tr>
<td>22</td>
<td>17.2</td>
<td>8.4</td>
</tr>
<tr>
<td>24</td>
<td>20.7</td>
<td>4.9</td>
</tr>
<tr>
<td>27</td>
<td>26.3</td>
<td>0.0</td>
</tr>
</tbody>
</table>

The following advantages were identified to this concept:

1. The cost per gallon of basin storage (approximately $2.30 per gallon) is less than the cost per gallon of tunnel storage (ranging from $7.15 to $8.47 per gallon depending on tunnel diameter). Therefore, this concept could reduce the OCI Tunnel total project cost. The estimated cost savings could be up to $30 million.

2. The current OCI Tunnel project requires a large diversion structure at the outlet of the tunnel (OCIT-1 Diversion Structure). The preliminary design has inside dimensions that provide approximately 2.2 million gallons of possible storage volume. However, the approved LTCP Update does not allow the City to count this volume as part of the 25.6 million gallon OCI Tunnel storage requirement. If USEPA and OEPA approved a storage basin concept, the diversion structure could be incorporated into the basin.

3. By strict volume calculations, a 12 million gallon storage tank could allow the City to reduce the 6150 foot long OCI Tunnel diameter to 20 feet. Constructing a smaller tunnel is likely to be feasible for a greater number of contractors, thereby increasing competition for the project and likely lowering bid prices.

The following disadvantages were identified to this concept:

1. The storage tank would require regular cleaning and maintenance, and top access could be limited.

2. The storage basin requires a larger footprint than the proposed diversion structure on a site that has limited space. This basin would limit the land available for the future EHRT facility.

3. Potential odor concerns and surrounding neighborhood impacts would likely require a fully covered basin.

4. A basin at the site could increase traffic to/from the site for required O&M.

5. Requires USEPA and OEPA approval to move required storage volume from the tunnel into a basin.
This concept should be studied further to determine the optimum tank / tunnel size combination. Once the optimum combination is determined, and if potential savings are significant, the USEPA and OEPA should be contacted immediately to begin technical discussions. Meanwhile, the OCI Tunnel final design should continue to advance as originally planned until agency approval is obtained.

**Oversizing Consolidation Sewers in the OCI Tunnel System**

This concept involves oversizing the Rack 16-17 Consolidation Sewer to store flows prior to reaching the OCI Tunnel. The LTCP Update design criteria specifically exclude “conveyance tunnels” from the minimum storage volume calculations, so this concept requires USEPA and OEPA approval; however, the USEPA and OEPA may consider approving in-system storage.

This concept should be studied further to determine the optimum consolidation tunnel / OCI Tunnel size combinations. Once the optimum combination is determined, and if the potential savings are significant and the risks are acceptable, contact should be made with USEPA and OEPA to begin technical discussions. The OCI Tunnel final design should continue to advance as originally planned until USEPA and OEPA approval is obtained.

**Extended OCI Tunnel**

Currently, the OCI Tunnel is proposed to begin at the corner of Dart and Exchange Streets. A 12-foot diameter consolidation sewer conveys flow from Rack 16-17 Drop Shaft to the tunnel. The extended tunnel alignment concept is based on turning the TBM at the OCIT-3 shaft and continuing east on Exchange Street to a new shaft at Bowery Street. It is estimated that extending the tunnel 1500 feet to Bowery Street would allow the OCI Tunnel inside diameter to be reduced from 27 feet to approximately 24 feet.

The following advantages were identified to this concept:

1. Reduces project cost by reducing tunnel diameter (cost savings up to $15 million).
2. Does not require USEPA or OEPA approval because the LTCP allows for “any other combination of diameter and length that achieves the design criteria.”
3. The City may realize cost savings by eliminating the 12-foot I.D. Rack 16-17 Consolidation Sewer and making the OCI Tunnel longer.

The following disadvantages were identified to this concept:

1. The current alignment along S.R. 59 cannot be easily modified to accommodate a single continuous curve onto Exchange Street without impacting existing ODOT bridges on S.R. 59 or existing buildings on either side of Exchange Street.
2. Cost savings achieved by decreasing the OCI Tunnel diameter would be partially offset by the cost of the OCIT-3 turning shaft. In addition, this alternate requires the TBM to make two large diameter penetrations through the turning shaft walls into granular conditions below the groundwater table (one entry and one exit).
Both of these penetrations could be very challenging due to soil and groundwater conditions. The project schedule would have to be modified to include several months required to turn the TBM in the shaft.

3. Limited geotechnical data along Exchange Street suggests the bedrock surface rises between Bowery and Main Street. Depending upon the termination point of an extended tunnel, mixed face and possibly full face rock conditions could be encountered by the TBM.

4. The TBM retrieval shaft would be moved farther east, towards the Akron Children’s Hospital campus. This could be more intrusive to the general public.

5. The minimum curve radius achievable by TBMs is too great to avoid crossing through a large portion of the properties south of the Considine Building. Akron Children’s Hospital (ACH) has plans to expand the existing Considine Building onto this property, and this tunnel would likely have a greater impact on those plans.

6. Extending the tunnel could move the OCIT-3 Drop Structure further east.

7. If the baffle drop into the OCI Tunnel is moved from Dart Avenue to either Water Street or Perkins Park, and the Rack 16-17 Drop Shaft is still necessary to convey flows to the new drop shaft, this alternate would then require a total of three shafts on Exchange Street (turning shaft, deep baffle drop shaft, and Rack 16-17 Drop Shaft), an increase of one shaft when compared to the two shafts (OCIT-3 Drop Shaft and Rack 16-17 Drop Shaft) shown in the Preliminary Design drawings. An additional shaft would likely increase the construction cost, partially offsetting savings achieved by downsizing the OCI Tunnel.

8. The City may have a permanent drop shaft in Perkins Park or in the parking lot south of Canal Park Stadium. These areas may be more difficult to access for operations and maintenance. These areas may also be more sensitive to potential odor issues from the shafts and tunnels.

9. This concept would require odor control facilities at the baffle drop structure to control odors due to structure depth and more turbulence and air flow.

10. A large diameter tunnel along Exchange Street could increase the potential risk of settlement. This area also has more sensitive structures and has the potential to have greater impact to the public than the current alignment.

11. There is currently insufficient geotechnical data to determine if an EPB or Slurry face TBM is necessary to successfully install a tunnel along the Rack 16-17 alignment (Exchange Street). TBM requirements for the Exchange Street reach of an extended OCI Tunnel may control the TBM selection. A slurry face TBM could have a higher procurement and operating cost, and has different limitations than an EPB TBM.

12. May be a significant increase in number and magnitude of utility relocations necessary if a rescue shaft is required for the TBM.
It is recommended this concept be studied further to determine potential savings, disadvantages, and advantages of this concept. Since this option does not need USEPA and OEPA approval, it can be implemented into the Final Design immediately after it is authorized.

**Stacked EHRT and Storage Basin**

The goal of this concept is to maximize the size of a storage tank at the downstream end of the OCI Tunnel in order to reduce the tunnel diameter as much as possible.

As discussed above, an estimated 12 million gallon tank is the largest tank that can be built and still provide sufficient space for the future EHRT facility. This concept allows a large storage basin by constructing a deeper storage basin and placing the EHRT facility on top of the storage tank at a later date. Dry weather flows discharge to the LCI by gravity flow. During wet weather events, flow would be dropped down into the storage basin until it reached capacity. The basin and OCI Tunnel would fill. Once the storage basin and tunnel reach capacity, a minimum 300 MGD flow rate would be directed into the EHRT facility.

After the wet weather event, the stored combined sewage in the OCI Tunnel could be dewatered by gravity to the LCI, and the combined sewage in the deep tank could be pumped into the LCI.

Flows greater than the EHRT capacity would be discharged directly to the Little Cuyahoga River. After the rain event, the stored volume in the OCI Tunnel would be directed by gravity to the LCI. The combined sewage in the deep storage tank would be pumped into the EHRT.

The following advantages were identified to this concept:

1. By stacking the EHRT facility on the storage tank, the basin volume would increase. By strict volume calculation, a 21-1/2 million gallon storage basin would reduce the 6150 foot long OCI Tunnel diameter to 12 feet, which is the minimum diameter necessary to convey the peak flow rates.

2. The cost per gallon of storage for the storage basin is less than the cost per gallon of tunnel storage. Therefore, this concept reduces the OCI Tunnel project cost by reducing tunnel diameter.

3. The current OCI Tunnel project proposes a large diversion structure at the outlet of the tunnel (OCIT-1 Diversion Structure). The preliminary design has inside dimensions that provide approximately 2.2 million gallons of possible storage volume. However, the approved LTCP Update does not allow the City to count this volume as part of the 25.6 million gallon OCI Tunnel storage requirement. If USEPA and OEPA approved a storage basin concept, the diversion structure could be incorporated into the basin.

4. Constructing a smaller tunnel is likely to be feasible for a greater number of contractors, thereby increasing competition for the project and likely lowering bid prices.
The following disadvantages were identified to this concept:

1. A pumping station would be necessary to dewater the storage basin.

2. If the City were to build a storage basin larger than 12 million gallon, with a tunnel as small as 12 feet in diameter, air flow and surge could become a critical issue.

3. The storage basin structure would have to be designed to support the future EHRT facility, including the weight of the facility filled with sewage. Due to the need for a minimum OCI Tunnel diameter to convey the peak flow rate to the LCI and the EHRT facility, the available costs savings for a larger basin may not be enough to offset the required structural upgrades needed to support the EHRT facility.

4. The deep storage basin would require regular cleaning and maintenance, and top access could be limited.

5. The EHRT facility is scheduled to be constructed at a later date, while the basin would be constructed as part of the OCI Tunnel project. The structural design of the deep storage tank would require assumptions to accommodate the future design. Additional retrofits or conservative assumptions might be necessary, which may result in additional cost to the OCI Tunnel project.

6. Requires USEPA and OEPA approval to move required storage volume from the tunnel into a basin.

6. The additional maintenance requirements would likely increase regular O&M traffic to and from the site.

It is recommended this concept be studied further to identify potential savings, disadvantages, and advantages of this concept. If the City is interested in pursuing this option, and if potential savings are significant, the USEPA and OEPA should be contacted immediately to begin technical discussions. Meanwhile, the OCI Tunnel final design should continue to advance as originally planned until agency approval is obtained.

2.13.3 Additional Alternate Concepts

On September 12, 2012, five (5) additional alternate project concepts were added for consideration. A memorandum describing the concepts, preliminary engineering, and cost analyses is provided in PER Appendix FF. Evaluations of these additional concepts were presented to the City on October 15, 2012. The additional alternate concepts are listed and then described in detail below:

- Move site for future EHRT to north side of Little Cuyahoga River and plan to convey flows in an aerial sewer across the river.

- Revise OCI Tunnel alignment along S.R. 59 to permit a smaller diameter tunnel to be extended into the Exchange Street ROW to the Rack 16-17 area, and place a deep baffle drop shaft at the current Rack 16-17 Drop Shaft location (variation of alternative discussed in Section 2.13.2)
Extend smaller diameter OCI Tunnel southwest beneath Dart Avenue past Exchange Street to Opportunity Parkway.

- Reconfigure and relocate the entire or part of the Rack 16-17 Diversion Structure to an open area on the south side of Exchange Street.

- Re-align Rack 16-17 Consolidation Sewer to stay in the Exchange Street ROW past Perkins Park and Water Street.

Move EHRT Site North of Little Cuyahoga River with Aerial Sewer Crossing

This alternative concept consists of relocating the proposed site for the EHRT to property on the north side of the Little Cuyahoga which is bounded by Otto Street and Cuyahoga Street. The property is being purchased by the City, and would be offered to the OCI Tunnel contractor as a construction staging area. Once the OCI Tunnel was filled, the next 340 MGD of flow would be conveyed by gravity in an aerial sewer extending over the Ohio and Erie Canal Towpath Trail, over the Little Cuyahoga River, and then underneath existing Ohio Edison electrical power transmission lines. A drop structure into the EHRT would be necessary. For the preliminary concept analysis, pipe supports were located outside the Little Cuyahoga River to simplify permitting. An 8 foot diameter steel pipe that spans 75 feet across the river was considered for the evaluation. The Opinion of Probable Construction cost to construct the pipe and its supports is approximately $1 million dollars.

Apparent advantages and disadvantages are summarized below:

**Advantages**

- Frees up space at Hickory Street site for a larger storage basin which could reduce OCI Tunnel diameter and costs (is approved by USEPA and OEPA).

- Simplifies maintenance/operations access to EHRT system.

- Simplifies construction access to EHRT.

**Disadvantages**

- Separates CSO storage and treatment, which need to function together, on opposite sides of river.

- Potential impact to Towpath Trail.

- EHRT system closer to residential neighborhoods and possible areas for future development.

- Ongoing maintenance requirements for steel pipe.

- May be aesthetically unacceptable.

- Less of the City-purchased land would be available for potential relocation of Rack 22 storage basin (and others).
- May not be possible if USEPA and OEPA does not approve additional storage outside of tunnel diameter/length combinations.
- USACE permitting requirements.

**Revise OCI Tunnel and Extend Along Exchange Street ROW to Racks 16 and 17**

This alternate concept would relocate the OCIT-3 Drop Shaft as it is currently designed to the Rack 16/17 area. The OCI Tunnel would be realigned at Market Street to extend beneath Rand Street until approximately the Locust Street Bridge, and then curving beneath S.R. 59 across Akron Children Hospital’s parking lot at Dart and Exchange Streets, and into Exchange Street ROW. As a result of this extension, the Rack 16-17 Consolidation Sewer along Exchange Street would be greatly reduced or eliminated altogether. Assumptions used for the evaluation are as follows:

- The turn radius of the tunnel alignment should be between 30 and 40 times the tunnel bore diameter.
- The tunnel should avoid going beneath bridge piers of the exit ramp from S.R. 59 to Dart Avenue.
- The tunnel should encroach as little as possible onto the Akron Children’s Hospital property at the corner of Dart and Exchange Streets.
- The option should not require additional land purchases.

Analyses indicate the OCI Tunnel can meet the requirements listed above, has a maximum inside diameter of 14 feet (based on a 16-foot diameter tunnel bore), and a length of 8,350 feet. The tunnel alignment radius would also need to be approximately 480 feet. This tunnel would encroach onto approximately 200 feet of Akron Children Hospital’s property (as measured along Exchange Street, beginning from the ROW corner at Dart and Exchange Streets). Tunnel storage volume would be approximately 9.6 million gallons. Based on the current conceptual analysis, the OCI Tunnel LTCP cost is approximately the same as the cost for this alternate concept.

**Extended OCI Tunnel Further Southwest in the Dart Street ROW**

This concept would extend the OCI Tunnel through the OCIT-3 Drop Shaft and southwest in the Dart Street ROW as far as Opportunity Parkway. OCIT-3 Consolidation Sewer would be necessary to convey flow from Rack 16-17 to the OCIT-3 Drop Shaft. Extending the OCI tunnel would permit the tunnel to meet the storage requirement with a smaller internal diameter. The Final Designer is currently analyzing this option and should provide results on October 15, 2012.

**Relocating the Rack 16-17 Diversion Structure Further South**

This concept investigated the impact of moving Rack 16-17 Diversion Structure and shaft out of the Ohio Canal and away from Canal Park Stadium parking lot on the north side of Exchange Street. Two potential alternatives, numbered Option 1 and Option 2, were analyzed.
Rack 16-17 Relocation Option 1 requires two diversion structures smaller than shown on the current Preliminary Design drawings. Rack 17 diversion structure could be on the north side of Exchange (in the Canal Park Stadium parking lot). Rack 16 diversion structure could be in an open park area adjacent to the Ohio Canal and Exchange Street. The Rack 16-17 Drop Shaft could then be located in the same park area as the Rack 16 Diversion Structure. Flows from Rack 17 diversion structure could be conveyed in a new consolidation sewer, under the Exchange Street embankment, into the drop structure. Overflows from both diversion structures would tie into the existing overflow pipes and into the Ohio Canal. The Opinion of Probable Construction cost for Alternate 102 is approximately $44 million dollars, compared to $37 million dollars for the system shown in the August, 2012 Preliminary Design Drawings. Advantages and disadvantages to this option are summarized below:

**Advantages**

- Smaller diversion structures.
- Structures do not need to be built under the towpath or the canal.
- Straighter alignment of the OCIT-3 Consolidation Sewer.
- Less impact to Akron Children’s Hospital expansion plans for the Considine Building, and less potential for impact to Perkins Park.
- Structures likely easier to operate and maintain, and more accessible.
- Likely less impacts to Towpath Trail.

**Disadvantages**

- Increased number of structures and tunneled pipelines.
- Increased risk of the damaging the Exchange Street Bridge.
- Potential conflicts with the existing steam lines and pressure reducing station.
- Possible construction conflicts with the footings from the former B.F. Goodrich Department Store.

Rack 16-17 relocation Option 2 is similar to Option 1, except the Rack 17 Diversion Structure is located in the Exchange Street ROW instead of the Canal Park Stadium parking lot. Overflows from both diversion structures would tie into the existing overflow pipes and into the Ohio Canal. This option would only be feasible if the OCIT-3 consolidation sewer is realigned to extend down Exchange Street and under the Exchange Street Bridge. The Opinion of Probable Construction cost for Alternate 103 is approximately $43 million dollars, compared to $37 million dollars for the system shown in the August, 2012 Preliminary Design Drawings. Advantages and disadvantages are summarized below.
Advantages

- Structures do not need to be built under the Towpath Trail or the Ohio Canal.
- Straighter alignment of the OCIT-3 Consolidation Sewer.
- Less impact to Akron Children’s Hospital expansion plans for the Considine Building, and less potential for impact to Perkins Park.
- Structures likely easier to operate and maintain, and more accessible.
- Likely less impacts to Towpath Trail.

Disadvantages

- Increased number of structures and tunneled pipelines.
- Increased risk of the damaging the Exchange Street Bridge.
- Potential conflicts with the existing steam lines and pressure reducing station.
- Possible construction conflicts with the footings from the former B.F. Goodrich Department Store.
- Potential impact to local businesses due to proximity of smaller diversion structure.
- Operations and maintenance required in Exchange St. after construction.
- Increased conflicts with existing utilities in Exchange St.

Realign the Rack 16-17 Consolidation Sewer Fully into Exchange Street ROW

This concept revises the August 2012 Preliminary Design drawings by moving the OCIT-3 Consolidation Sewer alignment into Exchange Street for its entire length from Dart Street to the Ohio Canal. The sewer would no longer pass through Perkins Park or across the properties or alley south of the Considine Building. At Water Street, the new consolidation sewer alignment could curve under the Exchange Street bridge structure and into the Canal Park Stadium parking lot. The Rack 16-17 Drop Shaft would have to be built further south in the parking lot to accommodate the new consolidation sewer alignment. This alternate analysis assumed the Rack 16-17 diversion structure is built as shown on the August 2012 Preliminary Design drawings. If the Rack 16-17 Diversion Structure relocation Alternate No. 103 is selected (see discussion above), this realignment would have to be designed, but with the alignment curving south under the Exchange Street Bridge. The Opinion of Probable Construction cost for the realigned OCIT-3 Consolidation Sewer is $44 million dollars, compared to $37 million dollars for the system shown in the August, 2012 Preliminary Design Drawings. Advantages and disadvantages are summarized below.
Advantages

- Straighter alignment of the OCIT-3 Consolidation Sewer.
- Less impact to Akron Children's Hospital expansion plans for the Considine Building, and less potential for impact to Perkins Park.

Disadvantages

- Increased risk of the damaging the Exchange Street Bridge.
- Increased number of access manholes in Exchange Street for the OCIT-3 Consolidation Sewer, and increased construction scope at the stadium parking lot.

A meeting was held on October 15, 2012 with the City, Final Designer, and Preliminary Design Team to discuss the additional alternate concepts. As a result of this meeting, the following decisions were made on each of the alternates.

- Moving the EHRT Site North of Little Cuyahoga River with Aerial Sewer Crossing
  - An aerial sewer crossing with 14 feet clearance above the towpath and 6 feet clearance below the First Energy high transmission is not feasible or preferred by the City.
  - After the meeting, the City learned that First Energy's minimum clearance requirement from the power lines is 20 feet, confirming the option is not feasible.
  - An evaluation should be conducted to determine if the same EHRT site relocation could be feasible using a siphon under the Little Cuyahoga River.

- Revise OCI Tunnel to Extend Along Exchange Street ROW to Racks 16 and 17
  - The City was not in favor of this alternative because there wasn't a cost benefit to the extended tunnel alignment.

- Extending the OCI Tunnel Further Southwest in the Dart Street ROW
  - This concept was removed from any further evaluations because it added extra cost without adding any operational benefit to the system.

- Relocating / Reconfiguring the Rack 16-17 Diversion Structures
  - The City was generally in favor of Option 2 because it removed proposed structures from the Canal Park Stadium Parking Lot. O&M for structures outside of this parking lot is simplified from the City's perspective. This alternative should be evaluated further during final design.
2.14 Wetland and Endangered Species Evaluations

Wetland Evaluation

A wetland evaluation was completed at project sites expected to be disturbed during construction activities. This evaluation included site locations for drop shafts, diversion structures, and the OCI Tunnel mining site. A site visit was conducted in April 2012 at each site. The only site that warranted a wetland delineation was the OCI Tunnel mining site. A wetland delineation was performed for the area shown on Figure 2-20, approximately 15 acres in size, in accordance with methods outlined in the 1987 US Army Corps of Engineers Wetland Delineation Manual and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual – Northcentral and Northeast Regional Supplement.

USACE defines an area as a wetland if it contains positive indicators of each of the three parameters, which include hydrophytic vegetation, hydric soils, and hydrological characteristics at selected soil test pits. Eight (8) soil test pits were completed in the
mining site study area at least 13 inches deep to evaluate if the three indicators of wetlands were present. Based on these field investigations, no Federal jurisdiction or State isolated wetlands were present in the study area, with the exception of the Little Cuyahoga River flowing through the northern portion of the site. The Little Cuyahoga River is considered a Federal jurisdiction water feature under the USACE. Stream impacts that occur below the ordinary high water mark of this water feature would likely require a permit from the USACE and possibly the OEPA. The wetland delineation report is provided in PER Appendix S.

Endangered Species Evaluation

An endangered species evaluation was conducted at project sites expected to be disturbed during construction activities. The United States Fish and Wildlife Service (USFWS) indicates the potential presence of two federally listed species within Summit County; Indiana bat and northern monkshood. A preliminary site visit was conducted in April 2012 to evaluate the potential presence of the two species at drop shaft and diversion structure locations, and the OCI Tunnel mining site. The various area habitats were determined as unsuitable for northern monkshood. The OCI Tunnel mining site resulted as the only location where Indiana bat could potentially be present due to the presence of several large roost trees. A memorandum documenting the field investigations and observations is included in PER Appendix T titled “Federally/State Listed Species and the Ohio Canal Interceptor Tunnel.”

During an April 2012 field visit, the Rack 16-17 area and Rack 18/19 area was determined to not present suitable Indiana bat habitat. USFWS identifies nine issues important for evaluating the presence of Indiana bat habitat. Responses were prepared for these nine issues for the Rack 16-17 area and Rack 18/19 area in case USFWS requests information in the future regarding endangered species presence in these areas. The memorandum documenting the nine issue responses is included in PER Appendix T titled “Absence of Indiana bat habitat at several Ohio Canal Interceptor Tunnel project sites.”

After determination the OCI Tunnel mining site could potentially provide habitat for Indiana bats, a Technical Assistance Request letter was sent to USFWS. The letter contained background information about the project, information about probable disturbance areas and the activities that could take place at those sites, and the presence/absence of endangered species habitat. The letter requested assistance from USFWS with how endangered species evaluations should proceed on the project, especially in regards to the OCI Tunnel mining site if Indiana bat surveys would be needed. An addendum to the letter was issued to USFWS a few weeks later adding the site proposed as OCIT-1 contractor staging. The Technical Assistance Request letter and addendum, titled “City of Akron Ohio Canal Interceptor Tunnel Technical Assistance Request Letter 6/22/2012 – Additional Site” is included in PER Appendix T. USFWS sent a representative to visit the area in July 2012. It was determined an Indiana bat field survey would need to be conducted to determine if Indiana bats are present in the area. USFWS requires field surveys (mist net surveys) be conducted between May 15th and August 15th each year. The City contacted MetroParks of Summit County to perform mist net surveys for the project prior to the August 15th deadline. The report documenting the mist net survey results was submitted to USFWS for review in October 2012 and is included in PER Appendix T.
2.15 **Historical / Architectural Considerations**

As part of preliminary design, local historical landmarks and areas with high architectural and historical value were identified. Analysis of the project area was split into two phases. The first phase consisted of reviewing information from available sources, such as Ohio Historic Preservation Office, National Register of Historic Places, and Ohio Department of Transportation's Historic Bridge List. The results of this literature review were documented in a report included as PER Appendix G.

Phase 2 of the analysis consisted of reviewing the literature review data and comparing it to historic maps and atlases from the 19th and 20th centuries to track patterns in the City's historic development. A field review of the study area was conducted to record, photograph, and note on project mapping structures that are over 50 years old. Recorded structures not already on the Ohio Historic Inventory list were added. The Ohio Historic Preservation Office Section 106 project summary form was also completed. The report documenting this phase of the work, including the project summary form, is included in PER Appendix H.

Historical/Architectural resource information was incorporated into the Tunnel alignment selection workshop, as documented in PER Appendix P. The presence of historical or architecturally significant structures was considered when evaluating potential risks. The selected OCI Tunnel alignment is generally free of significant risks to historical structures, except as it relates to the Ohio Canal. However, the Rack 16-17 Consolidation Sewer is within proximity of sensitive structures. The project summary form contains a recommendation to coordinate with OHPO to determine what effect construction of the OCI Tunnel could have on local historical and architectural resources. This coordination would result in a mitigation plan or strategy to be incorporated into final design and construction contract documents.

2.16 **Community Impacts**

The OCI Tunnel, consolidation sewers, and drop shaft construction could impact community resources near construction staging areas located throughout the west side of downtown Akron as shown on Figure 2-21.

The staging areas located at the tunnel boring machine launching site and on Cuyahoga Street could impact the Towpath Trail as shown on Figure 2-22. An access bridge crossing both the Little Cuyahoga River and Towpath Trail would be required to connect both staging areas. The Final Designer for the OCI Tunnel may need to incorporate language into the plans to keep the Towpath Trail open to the public. There are also special events, such as the Akron Roadrunner Marathon, when the contractor would be required to make special accommodations.

The construction and staging site immediately south of Canal Park Stadium could impact the Towpath Trail and stadium parking as shown on Figure 2-23. This should be the responsibility of the OCIT-3 contractor.

To collect public input, it is recommended a committee of downtown stakeholders be convened to assess the implication of staging area locations and the impact of the Towpath Trail. This committee would meet early in the design stage to provide recommendations including safety, traffic control, handicap accessibility, length, and
location of Towpath Trail rerouting. The committee membership would be established by the City of Akron.

Traffic flow on S.R. 59 and major arterials near the staging areas may be affected during various stages of construction. Detour strategies and alternative routing would be developed in conjunction with input from the City of Akron and the Ohio Department of Transportation. An outreach program for affected businesses in the area is recommended to provide input regarding these decisions.

Notifications regarding changes to normal City operations should be provided to the public and downtown businesses through a variety of social media sources. The Mayor's Director of Communication could assist in providing appropriate and timely news releases regarding both the Towpath Trail operation and traffic disruptions.

The current OCIT-2 contract proposes shallow sewers in Market Street to capture flow from the Rack 19 watershed. Careful consideration should be given for this construction as it is a main artery for traffic across S.R. 59, and a national Highway System roadway.

The OCI Tunnel alignment is anticipated to cross beneath the St. Vincent St. Mary's football field. St. Vincent St. Mary High School utilizes this field for a number of various activities throughout the year, other than football. It is anticipated the tunnel would not affect activities at the football field. The OCI Tunnel designer and contractor needs to coordinate tunnel construction below the football field with St. Vincent St. Mary School contacts.
Figure 2-6
Ohio Canal Interceptor Tunnel
Community Impact
To Towpath Trail

Legend
- Alignment 4B
- Consolidation Sewers
- Staging Sites
- Parcels

Potential Impact to Towpath Trail
Cuyahoga Street Construction Staging Site
Tunnel Boring Machine Launching Site
Towpath Trail

Printed 8/20/2012

Figure 2-22
2.16.1 Construction Noise

OCI Tunnel project sites were studied where excess noise might be generated by construction activities. The study consisted of characterization of existing land usage around the OCI Tunnel project sites, identification of sensitive receptors, background noise monitoring at five (5) potentially sensitive locations, computer modeling of noise likely to be generated by construction equipment and truck traffic, and evaluation of potential impacts to sensitive receptors. The following paragraphs present a summary of the preliminary noise analyses results. Figure 2-24 shows the OCI Tunnel and consolidation sewer alignments with 5 noise monitoring locations. Details are presented in PER Appendix V.
The City does not have an ordinance specifically for construction noise. Transportation regulatory agencies have adopted noise standards and analysis procedures useful in assessing community noise effects for this project. The Ohio Department of Transportation (ODOT) has implemented requirements of the Federal Highway Administration (FHWA) in identifying impacts due to vehicular traffic noise on highways (FHWA 2011; ODOT 3 2011). The Federal Transportation Authority (FTA) has implemented noise requirements for bus and rail terminals. Areas surrounding the OCI Tunnel construction areas fall in the land use categories A (residential) and B (active sport areas, day care centers, hospitals, parks, places of worship, public or non-profit institutional structures, schools, and others). Both land use categories have a noise abatement category (NAC) of 67 dBA.

To establish existing noise levels, field measurements were taken on August 7 and 8, 2012 at the five locations shown on Figure 2-24. At four sites, M-1 through M-4, 15-minute measurements were obtained in the morning, afternoon, and evening. Night time measurements were not obtained at these sites because night time noise levels in these locations are expected to be similar to recorded evening levels. At M-5, one noise monitoring device was set up during the afternoon of August 7 and allowed to run continuously until the afternoon of August 8. The device logged sound levels every minute over a period of 21 hours, 41 minutes.

Two types of computer modeling were performed in order to predict noise levels generated by the OCI Tunnel project. Construction noise was modeled using the Roadway Construction Noise Model (RCNM), Version 1.1 (USDOT 2008) and truck traffic noise was modeled using the Traffic Noise Model (TNM) Version 2.5 (Anderson et al. 1998; Lau et al. 2004). These models produced screening-level estimates of future noise levels based on assumptions about equipment usage and locations, traffic volumes, etc. Shielding effects of buildings and intervening terrain were not included. Input data for the RCNM include existing noise levels, a list of up to 20 of the noisiest types of equipment to be used at the construction site, and the distance from each type of equipment to a receptor of interest. The model uses built-in values of noise emissions from each piece of equipment, adds them together, propagates result over the specified distance, and adds the resulting noise level to the existing level.

Preliminary analyses using the RNCM model indicates noise levels at M-2 and M-5 are predicted to reach 78 dBA, exceeding the NAC levels for the land use categories identified at those monitoring locations. Calculated preliminary noise level at the other three sites was 72 dBA. This exceeds NAC levels for residential areas and equals the NAC for commercial, noise-sensitive areas such as hotels and offices. “Pile Driving,” such as the installation of sheet piles for temporary earth support systems, is the activity predicted to have the largest single noise impact.

Several roads in the OCI Tunnel project area are expected to experience construction truck traffic. For this project, a simple two-lane, flat road with an equal number of trucks traveling each direction in an hour was modeled in TNM. For modeling purposes, trucks were assumed to be heavy. Receptors were located at distances varying from 25 feet to 500 feet from the edge of the travel lane. Traffic speed was modeled at 25 mph. The volume of truck traffic was modeled at 50 trucks per hour in each direction. The resulting noise level at 25 feet from the road is 66 dBA, which approaches the NAC for residential land use.
Based on results of the preliminary construction and truck traffic noise evaluation, project-related noise levels during construction may be sufficiently elevated to affect sensitive receptors. It is recommended additional noise analysis be performed during final design once more details of construction methods and durations are developed. Based on the detailed analysis, the need for noise mitigation, such as restricted working hours, restricted truck traffic routes, engine silencers, or others should be evaluated based on discussions with the City and potentially affected receptors.

2.16.2 Construction Vibrations

The OCI Tunnel preliminary design includes several structures to be excavated into competent bedrock (shale). The Geotechnical Data Report (GDR) indicates the rock cores of sandstones and shales failed at unconfined compressive strengths up to and slightly more than 32,000 psi. Contractors may want to utilize rock blasting as an excavation method at OCIT-1 Diversion Structure site and OCIT-2 Drop Shaft. The quantity of rock excavation at Rack 19 Drop Shaft is likely to be minimal, and the Rack 19 Consolidation Sewer is likely to be in weathered bedrock conditions not requiring blasting.

Blasting is a common rock excavating method, and it can be engineered to minimize risk. Potential impacts of allowing a blasting program on the OCI Tunnel project are described in PER Appendix W. The analyses and findings are summarized below.

When explosive charges detonate in rock, they are designed so most of the energy is used in breaking and displacing the rock mass. However, detonating charges can also cause some of the following undesirable actions to occur:

- Some of the energy can also be released in the form of transient stress waves, which in turn cause temporary ground vibration
- Detonating charges can create unplanned rock movement in the influence zone of the blast
- Detonating charges can create a release of high-pressure gas, which in turn induces air-overpressure (noise)
- Detonating charges can cause a release of airborne dust

For proposed shaft and portal excavations, it is likely smooth-wall blasting methods using light charges would be used in perimeter holes to prevent overbreak and cracking in rock beyond the desired limits of the excavations. With smooth-wall blasting, borehole pressures create radial cracks that are reduced greatly by decoupling charges from the walls on the bored holes. In other words, the diameter of linear charges is less than the diameter of the hole. By placing a series of lightly charged holes at the perimeter of excavations, a cleavage fracture is created when charges are fired with minimal delay time between adjacent holes.

Characteristics of ground motion caused by the stress waves induced by blasting can be measured in several ways. These measures include particle displacement, particle velocity, particle acceleration, and vibration frequency. Standard industry damage criteria and “safe levels” of ground motion are generally based on particle velocity and
frequency of motion. The response of humans to ground motion is primarily influenced by ground motion velocity and duration of the motion. Vibration intensity is expressed as Peak Particle Velocity (PPV) or the maximum particle velocity of the ground. Since ground-shaking speeds are generally quite low, it is measured in inches per second (in/s).

Persons often confuse particle velocity values with ground displacement. For instance, if a measured peak or maximum particle velocity is 0.25 inches, the ground has not moved a quarter of an inch. The actual temporary particle movement or displacement would be much less, because in one second of time, ground particles disturbed by blast vibration waves should oscillate back and forth many times in a second. This is why frequency of motion is important because, unlike earthquakes where frequency of motion is quite low, cycles of ground particle shaking (frequency) caused by blasting usually occurs at 10 to 50 Hertz (Hz). Since the ground particles are shaking back and forth or up and down so quickly, similar to running in place, they do not move far.

In Report of Investigations RI 8507, the US Bureau of Mines recommended the safe ground motion limits defined by the curves shown on Figure 2-25. These limits, ranging from 0.5 to 2.0 in/s in the measurable frequency range above 2 Hz are the basis for most regulatory blast-induced vibration levels throughout the United States. It is important to note these limits are specifically intended to prevent cosmetic crack damage in plaster or drywall in typical wood frame homes. They should not be applied to other structures and utilities.

![USBM RI 8507 "Safe Level" Vibration Curve from RI 8507](image)
Placement of inert stemming material, such as crushed stone, fine gravel or sand, in the collars of blast holes and in shafts to prevent extreme ejections of high pressure gases caused by exploding charges is the primary method of reducing blast noise. The intensity of audible noise and low-frequency pressure waves can be further reduced by placing blast mats or a shaft cover over the shaft opening before blasting.

Buried utilities including pipes, fiber optic cables, and electrical conduits are rarely damaged by blast-induced ground motions with intensity less than the 5.0 in/s safe level recommended for buried pipes. This limit should be included in specifications.

**OCIT-2 Drop Shaft Considerations**

Rock blasting at the OCIT-2 Drop Shaft would occur close to structures and public roadways, as illustrated on Figure 2-26. The closest structure to the shaft is the Remembering the Journey Banquet Facility located about 125 feet northwest of the shaft. According to the Ohio Historic Inventory, this building was built in 1914 for a cemetery monument business. The building has a concrete block foundation, concrete block walls with brick veneer, and asphalt shingle roofs. The building is not currently listed on the National Historic Register.

The excavation and blasting work would also occur in close proximity to Rand and Glendale Streets. Both of these streets are maintained by the City of Akron.

![Figure 2-26 OCIT-2 Drop Shaft Proximity to Existing Structures](image)

Blasting would be an appropriate method to excavate 60 or more feet of rock in the shaft between elevations 865.5 and 804.5. As shown in PER Appendix W, calculations using typical vibration attenuation constants for sedimentary rock indicate the charge-per-delay for the closest blast with a slope distance around 130 feet would be around 1.8 pounds. To satisfy a 0.5 in/s PPV requirement at the nearest building at this site, the depth of initial blast rounds would likely be around 4 feet and they might increase to 6 feet as
depth and distance increases. For blasting at or below Elevation 870, the contractor should be required to place a heavy shaft cover over the shaft collar to control noise and prevent rock ejections. Strict stemming requirements whereby at least 2 feet of inert sand or fine gravel is placed in hole-collars for good charge confinement is also recommended. Fumes should be controlled by specifying the use of Fume Class 1 explosives and requiring adequate ventilation to quickly dilute and disperse blast fumes venting from shaft collars or tunnel portals.

Due to heavy traffic flows, it is unlikely traffic would be stopped on SR-59 located 165 feet to the west of the shaft. Traffic on Rand and Glendale Streets should be stopped 500 feet from the shaft for five or so minutes during times blasts occur.

**OCIT-1 Diversion Structure Considerations**

If used at the OCIT-1 site, blasting would occur close to residential homes, commercial property, and overhead power lines. With blasting occurring 100 to 200 feet from buildings, occupants would most likely feel some shaking caused by blast-induced vibration and wall-window rattling caused by air-overpressure effects. Even if vibration is limited to 0.5 in/s, which is the lowest limit generally used for residential buildings, vibrations from blasts with time durations from 1 to 6 seconds are likely to be noticeable.

For blasting at this site, covering the blast area with mats or placing a heavy shaft cover would be critically important. If not dampened by a cover, air pressure waves would cause noticeable rattling of adjacent windows in the exposed walls of the homes. Blast mats or heavy shaft covers, constructed with wood planks on a steel frame, would also contain blasted rock that could otherwise be ejected during shaft blasts. Blast mats are generally used for the first three or so blasts because they can be placed and removed by an excavator with appropriate reach. Once the shaft is advanced 15 feet or so feet, shaft covers are usually used to buffer blast noise and contain blasted rock. Blasts should also be covered with mats or special covers to prevent flyrock from hitting overhead power lines and associated structures.

The use of controlled blasting methods in this area can be applied successfully to prevent damage to existing surface structures but extraordinary oversight would be required. Strict limitations would be included in the specifications and the size of charges-per-delay would be small. Work would be expensive because the size of blasts and excavation rate would be restricted due to vibration controls. It is recommended that the use of controlled blasting should be an available option for contractors.

Due to rock conditions likely to be encountered above the OCIT-2 and Rack 19 Drop Shaft inverts, the use of blasting methods is likely to be considered by the contractor. Table 2-11 shows a brief list of potential advantages and disadvantages for both blasting and mechanical excavation of the rock materials anticipated on this project.
<table>
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<tr>
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<th>Apparent Advantages</th>
<th>Apparent Disadvantages</th>
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<tr>
<td><strong>Blasting Methods</strong></td>
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<tr>
<td><strong>For Contractor</strong></td>
<td>• Likely higher production rate</td>
<td>• Requires specialty permits and licenses.</td>
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<td>• Blasting can be quickly adjusted to meet changing rock hardness and/or quality.</td>
<td>• Requires specialty subcontractor.</td>
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<td>• Short duration of noise impact to general public, and can be timed to be</td>
<td>• Could affect schedule if blasting periods are limited by contract.</td>
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<td>performed when the least number of persons will be affected.</td>
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<td>• Could lead to over-excavation of materials.</td>
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<td>• Potential to damage temporary earth support system or recently completed work</td>
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<td>elements.</td>
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<td><strong>For Owner</strong></td>
<td>• Higher production rates could lower costs.</td>
<td>• Potential to damage adjacent existing utilities or structures.</td>
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<td>• Giving contractor multiple excavation options (i.e. blasting or mechanical)</td>
<td>• Vibrations can be felt by humans at very low levels, so potential exists for public</td>
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<td></td>
<td>could lower bid prices.</td>
<td>complaints after every blast.</td>
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<td>• Allowing contractor to blast could reduce likelihood of receiving a claim for</td>
<td>• Construction Manager must have staff with training and support needed to properly</td>
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<td>“differing site condition” related to rock hardness in excavation.</td>
<td>oversee blasting work.</td>
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<td>• Owner can review and approve blasting plans prior to implementation to ensure</td>
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<td>public is aware and protected.</td>
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<td><strong>Mechanical Excavation</strong></td>
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<td><strong>For Contractor</strong></td>
<td>• Lower risk of damage claims because vibrations travel distance is likely to be</td>
<td>• Possible lower production rates.</td>
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<td>less than blasting.</td>
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<td>• Higher level of control could result in less over-excavation.</td>
<td>• Continuous noise and dust could lead to higher complaints over time.</td>
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<td>• Unanticipated variations in rock hardness could require multiple changes in</td>
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<td>equipment.</td>
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<td>• Long periods of sustained vibrations could damage utilities that would not have</td>
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<td>been affected by a short duration blast.</td>
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<td><strong>For Owner</strong></td>
<td>• Lower risk of damage claims and potential complaints from neighbors.</td>
<td>• Unanticipated variations in rock hardness could lead to claims for both production</td>
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<td>rate losses and equipment wear and tear.</td>
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2.17 **Community System O&M Review**

The following sections discuss the operations and maintenance strategies for CSO or SSO storage tunnel systems built and operated in the United States. The majority of this information was obtained from a 2005 study performed for the Massachusetts Water Resources Authority (MWRA) by Parsons Brinckerhoff Quade & Douglas, Inc. and Metcalf & Eddy, Inc., a Joint Venture (PBMEJV). Additional information on the Milwaukee CSO tunnel system was obtained from staff working for the Milwaukee Metropolitan Sewerage District (MMSD) and a March 2005 report entitled “North Dorchester Bay CSO Storage Tunnel, Second Draft Technical Memorandum on Tunnel Sedimentation Control”, provided in PER Appendix GG. The North Dorchester report provides information about maintenance of storage tunnel systems.

The 2005 MWRA study included a review of information obtained on sedimentation control practices and experiences in Chicago, IL; Milwaukee, WI; Toledo, OH; Rochester, NY; Dearborn, MI; Augusta, ME; and Richmond, VA. The information was gathered from a 1997 City of Toronto study, with updates by PBMEJV, and new information obtained by PBMEJV.

In general, the Toronto study identified three (3) general strategies for controlling build-up of sediment in CSO tunnel systems:

1. Development of flushing velocities in the tunnel by storm flows,
2. Use of external flushing water source, and
3. Use of mechanical systems that hold back water in the tunnel, then release in a flushing wave.

Six of the seven tunnel systems discussed in the 2005 study report have provisions for the use of an external water source. The external water source might be a river, canal, or fresh water lake. However, the authors found only two of the seven communities, which had provisions for flushing, actually used them on a somewhat regular basis (those being Dearborn MI and Augusta, ME). The authors also note the Dearborn and Augusta tunnels have tunnel slopes of 0.015% and 0.092%, respectively. The OCI Tunnel would have a slope of 0.15%, which is higher than the communities listed above except Milwaukee, WI and Richmond, VA. None of the tunnel systems listed above have a low flow channel. The OCI Tunnel grade would maintain a minimum average dry weather flow velocity of 2 feet per second without a low flow channel.

None of the tunnel systems listed above reported significant build-up of sediments in their tunnel. Odors result from sediment were either not reported, or controlled by back-draft dampers.

The large diameter wet weather storage tunnels are not inspected or cleaned at the frequency generally used for interceptors and laterals. The primary reason behind this is the belief the combined sewage conveyed to storage tunnels has a lower sediment concentration. In general, when storage tunnels have been inspected, the assumption is confirmed and they have been found to be clean and in good condition.
The following paragraphs summarize the experience in each tunnel system discussed in the 2005 study.

**City of Milwaukee, Wisconsin; Milwaukee Metropolitan Sewerage District**

Contact Name: Mr. Patrick Murray  
Contact Relevance: Part of JV Team hired to inspect the Inline Storage System (ISS)  

Length: 102,000 Feet  
Depth: 300 Feet  
Diameter: 17-30 feet  
Slope: 0.1% - 0.42%  
Storage Time: Pumped during and immediately following storm events  

Strategy: Scouring velocity of 3 fps. No low-flow channel provided. Sewage / lake water flushing system and sediment receiving system at treatment plant. Coarse racks (4" - 1 0") at diversion structures. No upstream grit sumps.

Operations: Flushing system and sediment facility at plant never used. See discussion below regarding full tunnel inspection. Pipe leading to pump station did develop sediment problem that required high pressure wash cleaning twice in 10 years. No odor complaints, carbon system in use. Floatables were not as great a problem as anticipated.

Additional Notes: In 1994, the Milwaukee Metropolitan Sewerage District (MMSD) put into operation over 19 miles of deep storage tunnels. The tunnels range in diameter from 17 to 32 feet. The tunnels are in bedrock materials at depths ranging from 200 to 300 feet below ground surface. Approximately 60 percent of the tunnel walls are unlined (i.e. exposed bedrock), and the remainder are concrete-lined. The lower quarter of the tunnel is lined with concrete for the full length. Large debris is removed upstream of the drop structures by bar racks with 6-inch openings. The system is dewatered by a deep pumping station, which is also protected by bar racks with 6-inch openings. The tunnels do not convey dry weather flows.

From 1994 to 2002, MMSD reportedly performed no maintenance on the system.

In 2002, MMSD hired a Joint Venture engineering-contracting team to visually inspect the entire system. The team obtained a specialty ATV vehicle formerly used to inspect oil and gas pipelines and outfitted it to obtain real-time audio and video recordings while the team traversed the pipe. During the inspection, the team encountered minor accumulations of sediment. One area of the tunnel had significant debris, but the team attributed that material to a major interceptor sewer break that occurred just prior to the inspection. The team observed areas on the tunnel walls where previous leaks had healed since construction, decreasing the total infiltration rate. The total cost of this inspection in 2002 was $1.2 million. PER Appendix X contains a short summary of the inspection task.

MMSD’s current operation and maintenance strategy for this tunnel is as follows:

1. Every 6 to 7 years, divers are hired to vacuum sediment and large debris out of the deep dewatering pump station well. The greatest sediment quantities were
the first year after construction and appeared to be limestone dust remaining after the mining operation.

2. In the last 5 years, MMSD has hired a private firm, Veolia, to operate the system. MMSD is requiring the operator to inspect the tunnel system every 10 years. Veolia is reportedly performing an inspection this year.

City of Chicago, IL – Tunnel and Reservoir Plan (TARP) System

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>575,000 Feet</td>
</tr>
<tr>
<td>Depth</td>
<td>45 - 320 Feet</td>
</tr>
<tr>
<td>Diameter</td>
<td>13-33 feet</td>
</tr>
<tr>
<td>Slope</td>
<td>not available</td>
</tr>
<tr>
<td>Storage Time</td>
<td>72 hours</td>
</tr>
</tbody>
</table>

**Strategy:** "Self-cleaning velocity." River water flushing system. No low-flow channel provided. No upstream screening floatables. No upstream grit sumps provided.

**Operations:** Flushing system never used except once to lower river level. No adverse impacts due to admitting floatables. Infrequent odors handled with back draft. The full tunnel length has not been inspected. As sections have been added, inspections of the immediate area have been conducted. For sediment removal it is anticipated a Bobcat type loader would be lowered into the tunnel for sediment collection.

City of Toledo, Ohio

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>18,300 Feet</td>
</tr>
<tr>
<td>Depth</td>
<td>50- 60 Feet</td>
</tr>
<tr>
<td>Diameter</td>
<td>13.5 feet</td>
</tr>
<tr>
<td>Slope</td>
<td>0.1%</td>
</tr>
<tr>
<td>Storage Time</td>
<td>12-36 hours</td>
</tr>
</tbody>
</table>

**Strategy:** Scouring velocity not available. No flushing system. Coarse racks (6") at shafts. No upstream grit sumps.

**Operations:** Starting dewatering within 24 hours minimizes deposition. No odor complaints. Two inspections conducted during the first year of operation at 6 and 12 months: overall no significant amounts of sediment; Some sediment found in the upstream end where there is no drop shaft.

City of Rochester, New York

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>158,400 Feet</td>
</tr>
<tr>
<td>Depth</td>
<td>60-200 Feet</td>
</tr>
<tr>
<td>Diameter</td>
<td>7-16 feet</td>
</tr>
<tr>
<td>Slope</td>
<td>0.1% - 0.03%</td>
</tr>
<tr>
<td>Storage Time</td>
<td>24-48 hours</td>
</tr>
</tbody>
</table>

**Strategy:** No low-flow channel provided. River and potable water flushing systems. Coarse racks at tunnel inlets. No upstream grit sumps.
Operations: Flushing performed prior to inspection. Odor complaints - added back draft dampers. Debris removed by small front-end loader. Tunnel remains relatively sediment-free.

City of Dearborn, Michigan

Length: 13,000 Feet
Depth: 166 Feet
Diameter: 19.3 feet
Slope: 0.015%

Strategy: In-line flush gate holds back flow in 1,300 ft of upstream tunnel length. River water available to supplement flushing volume. 6" bar screen at inflow.

Operations: Tunnel inspection twice a year. Flushing system used yearly. Debris monitored at drop structures.

City of Richmond, Virginia

Length: 5,900 Feet
Depth: 42-145 Feet
Diameter: 14 feet
Slope: 0.2%

Strategy: River water flushing system produces scouring velocity in tunnel. Designed to allow "Bobcat" access for cleaning; floor flat at pump station and shafts. Active cleaning of inlet sumps with special attention to areas near sand beaches.

Operations: Operational in May 2003, operated as intended during initial wet spring which resulted in numerous activation events.

North Dorchester Tunnel, Boston, MA – Metropolitan Water Resources Authority (MWRA)

Length: 11,000 Feet
Diameter: 17 Feet

Strategy: The 2005 Tunnel Sedimentation Control report recommended to MWRA that, based on historical experience, sediment accumulation in the North Dorchester Tunnel is unlikely to be a significant problem. Theoretical models suggested the annual sediment load in the tunnel be on the order of 3,400 cubic feet, which would only displace 25,400 gallons of CSO from the tunnel. Over a 10 year period, if spread evenly throughout the tunnel, the depth of sediment could be on the order of 0.65 feet. If that same volume were to be localized to isolated sections totalling 1,100 feet, the average 10-year sediment isolated accumulation could be 3 feet. Sediment modeling suggested that even after five years, the volume of accumulated sediment would not adversely affect the performance of the tunnel in terms of CSO and stormwater storage. However, the report suggested the 5-year accumulation would likely be of sufficient volume to justify mobilizing a cleaning crew (Bobcat, low-head muck hauler, vacuum truck). The report also suggested MWRA continue actively cleaning catch basins.
Operations: According to the staff who prepared the Tunnel Sedimentation Control Report, the tunnel has been completed for about a year, and reportedly no inspections have been performed as of yet.

Northeast Ohio Regional Sewer District (NEORSD), Cleveland, Ohio Area

Background

On September 28 2012, members of the Akron Engineering Bureau and OCI Tunnel preliminary design team attended a meeting with operations and maintenance managers at the Northeast Ohio Regional Sewer District (NEORSD). NEORSD is currently implementing a CSO Long Term Control Plan, and has several tunnel projects either completed or in process. The purpose of the meeting was to learn how NEORSD has operated and maintained large diameter, deep sewage tunnels in the past and how they plan to do the same for the very large storage tunnels being built as part of their LTCP. Conversation centered around the NEORSD Mill Creek Tunnel (MCT), which conveys both dry and wet weather flows to the Southerly Waste Water Treatment Plant (WWTP), the Euclid Creek Storage Tunnel (ECT), a CSO storage tunnel currently under construction which will be dewatered to the Easterly WWTP, and the Southwest Interceptor (SWI), which conveys flow from southwest suburbs of Cleveland to the Southerly WWTP. The following list includes some of the relevant information shared by NEORSD:

Strategy:

- NEORSD has baffle drop structures that have been in service for over a decade, and have not been inspected since construction. They suggested Akron consider inspecting their new baffle drop every 6 months for the first year, but after that a 5 year inspection frequency is probably fine.

- NEORSD told Akron that they have airflow coming up out of the baffle drop structures continually (not just during events) and that the design should take this into consideration.

- NEORSD has one baffle drop in a local metropark where they have had some odor complaints. They may be putting a vent pipe with a carbon filter system on it in the future.

- In general, NEORSD recommended Akron consider airflow in the drop structures during design. For example, based on later discussions with Mr. Tom Sisley of DLZ, NEORSD had an issue of odors that were thought to be caused by sediment buildup. However, after further investigation, it appeared that reverse airflow (suction) was occurring in one of their systems which drew odors from the sewer back to the drop structure.

- NEORSD has designed the Euclid Creek Tunnel diversion structures so that flows can be re-directed back into the interceptors if necessary so that the structures can be cleaned and tunnel maintenance can be performed.
Operations:

- NEORSD likes to have access shafts on the large diameter deep sewers at a maximum distance of 3000 to 4000 feet apart, primarily for safety of crews in the tunnels.

- NEORSD used to depend upon local Fire Departments for their confined space entry rescue services during deep tunnel inspections, but they have switched to training their own staff now. For full inspections, they hire outside contractors and consultants.

- NEORSD has vortex drop structures, which are protected by bar racks upstream of the drop. They inspect the bar racks once per year. They manually clean the bar racks.

- Until the Euclid Creek Tunnel project, NEORSD did not have bar racks upstream of their baffle drops. They told Akron that they have not had any reported problems with debris on the baffles.

- For the Euclid Creek Tunnel project, since it is a deep storage tunnel that will be dewatered through a pump station, NEORSD has elected to design grit and debris control in the shallow diversion structures. The bar racks were sized specifically to protect the pumps in the dewatering pump station. They plan on doing maintenance and inspections of these structures one time per year.

- In existing sewer systems such as the Southwest Interceptor and Mill Creek Tunnel, NEORSD plans a full condition inspection every 20 years. Inspections are performed by outside contractors.

- For the storage tunnel systems being built, NEORSD is planning to do condition inspections every 5 years for the first 10 years, and then probably shift to as much as 20 years between major inspections. This is based on their experience with the Mill Creek Tunnel, which has not had significant debris or grit accumulation problems.

- NEORSD is moving away from installing level sensors in the deep storage tunnels and sewers to monitor filling, and going towards “totalizing flow” at diversion structures to determine the volume in the tunnels at any one time.

Applications to OCI Tunnel Operations and Maintenance (O&M)

The storage tunnel systems described above are designed to receive flows only when the associated interceptors reach capacity and “overflow” into the tunnel. However, the OCI Tunnel would accept dry weather flows continuously and would receive flows during every storm event up to the capacity of the consolidation sewers (or until the tunnel is filled). This difference significantly changes the sedimentation characteristics from the typical CSO storage tunnel.

According to tunnel velocity calculations, at the currently proposed 0.15% slope, the 3.6 MGD average dry weather flow from Rack 16-17 Consolidation Sewer would be conveyed through the OCI Tunnel at a velocity of approximately 2 feet per second. This
is theoretically sufficient velocity to keep 3 millimeter (mm) diameter particles in suspension. An additional 15 MGD of average dry weather flow would enter the OCI Tunnel at the OCIT-2 Drop Shaft, theoretically increasing the flow velocity to over 3 feet per second.

Based on the hydraulic model, in a typical year there could be approximately 35 storm events which could create flow velocities over 4 feet per second in the tunnel. The flows would likely be even higher in isolated areas of the tunnel. Flow velocities in the 4 to 6 feet per second range are typically assumed to provide re-suspension of grit and small diameter sediment.

In summary, although the OCI Tunnel would receive a greater total volume of flow than typical CSO storage tunnels, it would also experience re-suspension velocities from the small wet weather events that come more frequently than tunnel-filling events, and would experience a flushing mechanism. The proposed OCI Tunnel design assumes the tunnel would be inspected on a 5-year cycle to fulfill Capacity, Management, Operations, and Maintenance (CMOM) requirements. Cleaning is proposed to be performed by manual cleaning methods as needed. This assumption would be confirmed in final design.