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TECHNICAL MEMORANDUM

TO:	Jeanne Powers, Onondaga County Department of Water Environment Protection	REF. NO.:	630812
FROM:	Christopher P. Martin, , P.E./jac/003 CPM	DATE:	April 1, 2013
CC:	Bryan T. Smith, P.E.; Casey W. Cowan, P.E.		
RE:	**Metro WWTP - Compliance Alternatives for Outfall 002 and Tertiary Treatment Bypass**		

On March 21, 2012, the Onondaga County Department of Water Environment Protection's (WEP) State Pollutant Discharge Elimination System (SPDES) Permit renewal for the Metropolitan Syracuse Wastewater Treatment Plant (Metro WWTP) took effect. The new permit includes stringent fecal coliform and total residual chlorine limits for the plant's secondary treatment bypass discharge outfall (Outfall 002). WEP must comply with these limits commencing on April 1, 2016. In addition, the potential exists that a future SPDES Permit modification could require WEP to disinfect tertiary treatment bypasses (designated as Outfall 001A). CRA Infrastructure & Engineering, Inc. (CRA) was retained by WEP to review these permit requirements and evaluate alternatives for compliance.

Figure 1 shows a general layout of the Metro WWTP. Secondary bypass flows are currently conveyed to an 800,000-gallon chlorine contact tank where sodium hypochlorite is used to disinfect bypass flows prior to discharge via Outfall 002. Sodium bisulfite is added for dechlorination prior to discharge to Onondaga Lake.

The existing bypass chlorine contact tank (BCCT) provides a theoretical contact time of 10 minutes at peak flow. Additionally, approximately 30 seconds of contact time is provided for dechlorination. A review of historic operating data shows that Metro would be unable to meet the new SPDES Permit requirements for fecal coliforms and total residual chlorine under the current treatment configuration. A preliminary analysis indicated that additional process tankage and associated chemical feed improvements would be essential to provide the facilities necessary to consistently achieve secondary bypass disinfection and dechlorination requirements. A key reason is that secondary bypass flow and water quality varies significantly from event-to-event; for example, flow can vary from less than one million gallons per day (mgd) up to 114 mgd in a matter of hours. Therefore, the available contact time does not provide sufficient time for plant operators to react to these rapidly changing conditions. In addition to the critical need for compliance, it was identified that additional process tankage would serve to capture additional phosphorus prior to discharge into the lake. More importantly, secondary bypass flows typically have 50 percent bioavailable phosphorus. Providing added phosphorus capture would greatly enhance operating flexibility with respect to meeting the anticipated SPDES Bubble Permit for effluent phosphorus at Metro, particularly with respect to potential flow increases due to growth.

This evaluation considered the following alternatives for meeting the Outfall 002 permit limits:

- Alternative A – Construct additional process tankage adjacent to the existing Bypass Chlorine Contact Tank
- Alternative B - Reusing the existing abandoned tertiary clarifier tanks for secondary bypass disinfection and dechlorination

After reviewing with WEP the risks and disadvantages associated with reuse of the tertiary tanks as compared to construction of new process tankage, Alternative B was dismissed as a feasible option; the evaluation that led to this determination is summarized in Section 3.0 of this document. Therefore, this Memorandum focuses on the conceptual design and budgetary capital costs for new process tankage and associated facilities to consistently meet new secondary bypass disinfection and dechlorination requirements.

Tertiary bypass flows are currently conveyed via the existing secondary effluent 84-inch diameter pipe (referred to as "Big Blue") from the Secondary Effluent Pump Station (SEPS) to the abandoned Tertiary Pump Station wet well. High water level in the SEPS wet well causes overflow of weirs at the Tertiary Pump Station wet well resulting in a tertiary bypass. In an effort to maximize tertiary treatment of flows, Metro staff send as much flow as possible to the SEPS during wet weather; this in turn reduces the amount of secondary bypass. However, secondary treatment effluent flows occasionally exceed the SEPS capacity, which leads to a tertiary bypass. Tertiary bypasses also occur when the tertiary processes have reduced hydraulic capacity due to maintenance needs. The tertiary bypasses are directed to the main plant Outfall 001, and this flow stream is designated as Outfall 001A. This memorandum includes a review of options to disinfect and/or mitigate tertiary bypasses should the requirement become a permit condition in the future.

1.0 SECONDARY BYPASS DISINFECTION DESIGN CRITERIA

Metro's SPDES Permit requires disinfection of all secondary bypasses during the disinfection season (April 1 to October 15) for plant flows exceeding the tertiary treatment capacity (approximately 126 mgd) up to a peak plant capacity of the plant headworks (240 mgd). Flows in excess of 240 mgd are bypassed directly into Outfall 001. Based on the Permit and plant process capacities, the peak secondary bypass flow is the difference in these flows - or 114 mgd. A review of plant secondary bypass data from 2005 and 2010 indicates that bypass events approached, but did not exceed, 114 mgd several times. The average of peak instantaneous bypass flows was approximately 45 mgd during this 6-year period. These flow rates represent the design flows for the conceptual design of the disinfection and dechlorination facilities. The fecal coliform and total residual chlorine limits as 200/ 100 milliliters (mL) and 0.1 milligrams per liter (mg/L), respectively; these limits are stringent and commonly found applied to main plant effluent, not bypass flows.

Sizing requirements for the process tankage was determined based on the required contact time for both sodium hypochlorite disinfection and sodium bisulfite dechlorination. Based on criteria set forth in the *Recommended Standards for Wastewater Facilities (Ten State Standards)*, the minimum required contact times for disinfection is 15 minutes and for dechlorination, 0.5 minutes at peak hourly flow. These times are common for secondary effluent, which typically has total suspended solids (TSS) and biochemical oxygen demand (BOD) concentrations below 30 mg/L. Primary effluent has a significantly greater concentration of solids, which reduces disinfection effectiveness. Also, the number of fecal coliforms requiring disinfection are significantly higher. To consistently achieve the fecal coliform limit a conservative approach is warranted.

White, in the 1999 *Handbook of Chlorination and Alternative Disinfectants – 4th Edition,* recommends chlorine contact times for disinfection of wastewater of between 30 and 60 minutes. An analysis was performed using a method presented in the United States Environmental Protection Agency's (USEPA's) *1986 Design Manual for Municipal Wastewater Disinfection.* This method can be used for calculating chlorine contact times based on initial chlorine dose, initial fecal coliform concentration, design effluent fecal coliform concentration, and chlorine contact time.

Historical data from the Metro WWTP provided in a Water Environment Research Foundation (WERF) 2005 Report, *Identifying Technologies and Communicating the Benefits and Risks of Disinfecting Wet Weather Flows* was used to establish initial fecal coliform levels. The report indicates that Metro's pre-disinfection secondary bypasses have fecal coliform counts up to 35,000,000/100 mL, which is consistent with information found in White (1999). Bypass effluent analytical data provided by WEP for events between 2010 and 2012 also shows peak counts approaching 3,000,000 /100 mL.

Using a maximum initial chlorine dose of 20 mg/L, the disinfection contact time at design peak flow (114 mgd) was determined to be approximately 30 minutes. Dechlorination using sodium bisulfate has significantly faster reaction kinetics than chlorine disinfection. The *Ten States Standards* recommends a contact time of no less than 30 seconds at peak flow. However, effectiveness may be somewhat reduced with primary effluent instead of plant effluent. Additionally, the discharge from the bypass chlorine contact tank is very close to the lakeshore. Therefore, a conservative contact time of 5 minutes at peak flow was used.

Based on the disinfection and dechlorination contact times and a peak flow of 114 mgd, a total process tankage volume of approximately 2.8 million gallons (MG) would be required. Solely for the purpose of chlorine storage and feed system sizing, a maximum chlorine dose of 25 mg/L was assumed. It is critical to note that primary effluent quality can vary widely and disinfection performance is impacted by temperature. Therefore, a bench-scale testing program should be developed and performed during the preliminary design phase to determine the expected operating envelope for the disinfection and dechlorination facilities. This would permit WEP to establish a site-specific design dose to more effectively size chemical storage and feed facilities. The testing program should include development of a series of dose-response curves that are representative of the varying flow, temperature and water quality conditions of secondary bypass flows that are encountered during disinfection season with the Metro secondary bypass. Influent water quality consideration should include fecal coliform, total suspended solids and biochemical oxygen demand. The chlorine demand under varying wet weather conditions also should be considered. The end result of the testing must show the sodium hypochlorite dose required to meet the new 200/100 mL fecal coliform limit during first flush conditions at anticipated water temperature and varying flow rates (e.g., contact times). Consideration also should be given to extended operation when influent fecal coliform levels are lower and chlorine dosage can be reduced.

An ancillary benefit of the process tankage would be capture of phosphorus-laden water. The disinfection process tankage would be designed to retain the first 2.8 MG of secondary bypass. This would be returned to the head of the plant after the wet weather event for full treatment. Based on the 1991 precipitation year, which is considered the historical average for wet weather, 2.8 MG of process tankage would reduce the average secondary bypass discharge to the lake by about 16 percent. Using the 2005 to 2010 average phosphorus load to the lake from Outfall 002, phosphorus discharge to the lake would be reduced by an average of approximately 670 pounds/year. This additional removal of phosphorus can be of significant benefits to WEP's efforts in complying with the anticipated Bubble Permit, particularly during wetter years or should Metro's flows increase. It also is noteworthy that tertiary bypasses have effluent phosphorus concentrations greater than the tertiary effluent. Capturing tertiary bypasses within the larger process tankage also would result in an ancillary phosphorus removal benefit

2.0 ALTERNATIVE A - NEW PROCESS TANKAGE

The 2.8 MG of process tankage required to disinfect and dechlorinate the secondary bypass flow can be achieved by reuse of the existing BCCT connected in series with a new process tank. The existing process tank has a usable volume of approximately 800,000 gallons. Therefore, an additional 2.0 MG is required to provide the necessary process tankage volume to achieve 30 minutes of disinfection and 5 minutes of dechlorination contact time at peak flow.

Assuming the maximum volume is detained during a peak hydraulic grade condition, a tank with two 35-foot wide by 185-foot long chambers would provide approximately 2.0 MG of capacity. This tank would be located just north of the existing BCCT and to the west of Aeration Tanks F and G. Figure 2 illustrates the preliminary layout for Alternative A.

A detailed analysis of the size and layout of the new tankage is recommended after the secondary bypass testing program discussed above is completed. The analysis should present layout options with associated costs and consider items such as the unique geotechnical design requirements for tank construction, impacts to the railroad and the Onondaga County Water Authority (OWCA) transmission main to the north of the tank, impacts to WEP's ongoing treatment operations, chemical deliveries and vehicular access around the tank, and the future operation and maintenance of the existing aeration tanks and expanded BCCT process.

2.1 TREATMENT / FLOW PROCESS

Incorporation of a new process tank into the existing secondary bypass disinfection system would require rerouting of the existing 72-inch Secondary BCCT Influent pipe. As shown on Figure 2, a new interconnection would be used to redirect the existing pipe into the proposed tank. The new process tankage has a two chamber design that flows in series from the first to the second chamber. Flow would be controlled using a submerged intermediate weir. The isolation wall in this tank would facilitate capture of first flush solids within the first chamber. Bypass influent flows would be metered to allow flow pacing the chlorination and dechlorination feed. This could be accomplished by measuring water levels at the aeration tank bypass structures or by installation of a new flow meter on the 72-inch BCCT Influent piping. Sodium hypochlorite would be dosed at the entrance to the first chamber followed by mechanical mixers for dispersing the chemical into the flow column. Baffling within the chamber should be evaluated to reduce short circuiting. At the south end of the second chamber, a 72-inch conduit would convey flow from the new tank to an interconnection with the existing Secondary BCCT.

A new overflow weir wall would be constructed within the existing Secondary BCCT to divide the tank into chlorine contact and dechlorination zones. The chlorine contact zone would be hydraulically connected with the new tank. An existing separation wall with the BCCT would be removed to facilitate a new cleaning system within the existing tank. The dechlorination zone would have mechanical mixers to disperse sodium bisulfite and enhance contact and treatment.

The existing overflow weir at the south end of the BCCT would remain as the discharge control weir for secondary bypasses discharged via Outfall 002. Secondary bypass flows and volumes would be determined with a new flow meter on the existing secondary bypass piping to the outfall.

2.2 HYDRAULIC GRADE

The addition of new process tankage adds headloss to the secondary bypass system between the aeration tanks' bypass structures and the discharge into Outfall 002. A hydraulic analysis for the proposed system was performed to determine this headloss and the impact on the existing facilities. The existing 25-year flood elevation for Onondaga Lake (elevation 370.41 per plant datum) was used as reference elevation in the analysis. The *Ten States Standards* requires that a WWTP be protected from a 25-year storm flooding the plant discharge. Therefore, the existing Secondary BCCT effluent weir elevation (elevation 375.00) would not be lowered.

The hydraulic analysis was carried back through the proposed secondary bypass piping to the aeration bypass structures that collects secondary overflow from Aeration Tanks E, F, G, and H. This analysis assumes that the existing secondary bypass inverted siphon that goes under the effluent gallery is clean and the 60-inch overflow between the western aeration tanks and eastern tanks does not add significant headloss to the system. Additionally, the following assumptions were made:

- Each internal tank weir was modeled as a rectangular submerged weir
- The new tank weir and dechlorination zone weirs were designed to allow a 114 mgd peak flow at a maximum headloss of 1 foot
- The wash water retaining walls were modeled as submerged weirs

The analysis indicated that the new process tank weirs are the source of the most significant headloss within the proposed system. Frictional and minor losses from interconnecting piping between the tanks are also a factor. The proposed process tankage construction does increase water levels at the aeration tank bypass structures, but levels are estimated to be greater than 2 feet below the top of the existing bypass weirs during the peak flow.

A hydraulic analysis and hydraulic grade drawing are recommended upon establishment of the facility configuration during preliminary design.

2.3 CHEMICAL STORAGE, FEED PUMPS, AND UNLOADING AREA

Housing the proposed chemical facilities would involve constructing a new building in the area adjacent to the existing and proposed tanks. WEP has indicated that it does not want to rely on the existing chemical storage facilities for the new bypass treatment system. Sodium bisulfate and sodium hypochlorite crystallization and freezing of chemical lines have been an ongoing issue with the existing storage facilities. The crystallization results in scale that greatly reduces the capacity of the conveyance piping, thus necessitating periodic replacement of several hundred feet of double-wall piping through a congested area of the plant; this represents a significant operational and maintenance concern to Metro staff. Additional chemical storage also would be necessary to meet chemical dosing requirements. Constructing new chemical storage and feed systems inside a heated building adjacent to the BCCT would greatly reduce these problems. The building would house tanks for sodium hypochlorite and sodium bisulfite, as well as the chemical dosing pumps and associated feed piping. Additionally, this building would be used to house control and electrical facilities (e.g., instrument panels, HMIs, cabinets, drives) for equipment installed as part of the new bypass treatment system. The following list presents a summary of the major mechanical equipment that is anticipated within this building:

- Two 15,000-gallon storage tanks for sodium hypochlorite (size dependent upon chlorine dose testing results)
- Two 4,000-gallon storage tanks for sodium bisulfite
- Multiple chemical dosing/metering pumps to draw from each tank and dose into the proposed disinfection and dechlorination chambers. Low and high flow pumps may be needed to meet a range of flows.
- Chemical piping, valves, fittings, etc.

The chemicals stored in the new building would be dedicated to the secondary bypass system; the existing chemical building on site would be maintained for dosing the main influent bypasses.

To house both the mechanical equipment and the electrical/control equipment described above, it is estimated that a building footprint of approximately 2,000 square feet (40 feet by 50 feet) would be required. The building would require a usable interior height of approximately 30 feet. Space is available for such a building located to the south of the existing secondary BCCT. An evaluation should be completed to determine if the existing Metro WWTP low pressure steam heating system could be extended to heat the new building.

A new chemical tanker truck unloading area is necessary adjacent to the bypass chemical building. This area is depicted on Figure 2. Options are available to locate the unloading area to the east or west of the new chemical building. A delivery route for a 9,000-gallon capacity, 18-wheel tanker truck was projected between the new tank and the existing aeration tanks. The unloading area would require a containment curb, sump area, and chemical transfer piping in accordance with NYSDEC chemical bulk storage regulations.

2.4 SOLIDS CLEANING SYSTEM

Metro staff indicated a preference for clean in place systems for both the existing and proposed process tanks to flush settled solids from the tank floor after a secondary bypass event. A conceptual review of different tank cleaning technologies was performed. A flushing gate system is the preferred alternative for cleaning sludge from the floor of the proposed tank.

The flush-gate system includes sluice gates installed on a reservoir at one end of the tank, designed to capture a percentage of the bypass flow, which is stored as flush water until the tank is drained. To flush a drained or dewatered tank, the gates would be opened, releasing the retained volume into the tank chamber. The wave action created by the velocity of the wash water would sweep solids across the slope of the tank floor and into a sump area at the other end of the tank. The mixture of flush water and solids are then pumped out of the tank sump to the WWTP primary train for full treatment. WEP currently uses this type of system at the Midland Avenue CSO facility.

Preliminary discussions with a flushing system manufacturer provided a conceptual design for the proposed system. The new tank would require two flushing gates per tank chamber, for a total of four gates in the new tank. The gates would be anchored to 42-inch high retaining walls to serve as a flushing water storage area. If flush water is needed for the west chamber after an event that does not fill the west flush reservoir, a sluice gate would be installed on the face of the chamber dividing wall to allow water to fill the reservoir. A supplemental means to fill the flush water reservoir with secondary effluent water is also depicted. Concrete curbing would be needed along the entire length of the chamber floor to separate each chamber into two flushing zones. A tank bottom slope of 1 percent would be used to promote flushing. After a secondary bypass event, the flush gates would be operated individually to clean the four flushing zones.

The cleaning system in the existing BCCT would be a high pressure water nozzle system. A pressure-nozzle system was selected because of the smaller process tank size, anticipated lower cost, and the expected ease of retrofitting a simpler system to the existing tank. The tank retrofit for a pressure-wash system would be accomplished with the following improvements:

- Removal of the existing BCCT center wall
- Addition of concrete fill to the tank floor to create a slope for facilitating easier cleaning
- Construction of a new center trench for directing solids/cleaning water to the north
- Installation of new pressurized water nozzle devices (i.e., wash down turrets) and platforms for cleaning the tank
- Installation of high pressure pumps in the Plant Operations Building to draw secondary effluent water from the abandoned tertiary pump station wet well for tank cleaning. Reuse of the existing oxidative liquor pumps in combination with booster pumps at the new tank should also be evaluated.
- Installation of new high pressure secondary effluent watermain from the Plant Operations Building to the nozzle devices

2.5 DEWATERING SYSTEM

A centralized pump station for dewatering the existing BCCT and new process tank is depicted on Figure 2. The south end of the new tank would have a sump area to collect and drain bypass flow captured within the tank during an event. Once the new tank is dewatered, the sumps would also collect the flush water used for tank cleaning. A sluice gate would be installed between the two chamber sump areas to allow draining the east chamber into the west chamber during dewatering.

The bottom slope of the existing BCCT currently drains south to the sump pumps. Concrete fill would be installed to redirect the bottom slope to the center and north. A new sluice gate is depicted on the north end of the existing BCCT to allow dewatering to the new pump station. Existing sluice gates at the influent side of the existing BCCT are no longer necessary and would be removed.

Draining the tanks would be required at the conclusion of each bypass event and during operation of the tank cleaning systems. Submersible pumps located at the low point of the tank sump area would convey captured bypass water and cleaning water via force main to the primary clarifier influent distribution structure. Rail-mounted submersible pumps are recommended for easy access and maintenance. The top of the pump station wet well would need to be the same elevation as the new tank; therefore, to facilitate pump removals, a new Gantry hoist could be installed or a boom truck would be needed. Duplex pumps would be sized so either pump could dewater the total process tankage volume within 24 hours. Each pump would have a 3-mgd capacity.

2.6 TREATMENT CONTROLS / AUTOMATION

The controls and automation components for the new bypass system would be housed within the new bypass chemical building and/or a control building adjacent to the pump station. New control facilities would be programmable logic controller (PLC)-based, and would be responsible for providing remote operation of the tank mixers, chemical dosing pumps, and tank cleaning system. A general summary of the control requirements is presented in the list below:

- The tank mixers would require automation to initiate starts/stops based on a flow set-point entering the new tank.
- Electrical actuators for flushing and sluice gates require remote control.
- Chemical dosing pumps require flow-paced set-point control to regulate dosing into bypass system
- Dewatering pumps require remote operation to initiate starts/stops for tank draining operations. The pumps should be operated with VFDs to allow turn down during tank cleaning operations.
- Chemical tank level sensors would be monitored and displayed by the PLC.
- New flow meter(s) require relay signals to provide flow-pacing and start/stop signals to other system components (mixers, chemical pumps, etc.).
- Motorized valves for the chemical dosing system require automated control for open/close signaling based on pump operating condition.
- Return signals are required from the system PLC to the Plant Operations Center (POC) area to allow for remote operation and/or monitoring of all components from outside the chemical building.

Control conduit and wiring to tie together the individual tank components with the PLC would likely be underground, while relay signals to the POC could be achieved via radio or hardwired fiber optic signal through existing plant tunnels based on WWTP personnel's preference.

2.7 ELECTRICAL REQUIREMENTS

The main power service for the new bypass system would be housed within the new chemical building as described above. Equipment such as motor control centers, starters, electrical cabinets, power panels, etc., would be located in the building in a separate dedicated room to comply with electrical codes.

A review of existing plant electrical information would be required to identify the most effective source of power with an appropriate rating to service the new facilities. New wiring and conduit would be needed to operate the motors for the mixers, dewatering pumps, flush gate actuators, sluice gate actuators, and flow meter(s). Additional site lighting also would be necessary to provide for safe operation and maintenance.

2.8 STRUCTURAL DESIGN

Conceptual structural design for the new tank was based upon drawings of the existing BCCT, the bearing capacity of foundation piles, weight of the tank body, the underground depth to the tank floor, and the floor slope required for the tank flushing system. Taking these factors into account, a 2-foot thick concrete floor slab has been assumed for the preliminary cost estimate. As recommended by the flushing system manufacturer, the tank floor slab would slope downward from the south end at 1 percent to the south end of the tank. The tank walls were assumed to be 18 inches thick at the top and 24 inches thick at the bottom.

Stairs and structural platforms (not shown on the figures) would be required at both the new and existing tanks to provide access for maintenance of various tank components. Walkways would be provided along the center of the new tank, with a crossover located above the mixers to provide access. Stairs would be installed at the north and south ends of the tanks, with the bottom of entry to the stairs facing east. Walkways between the new and existing BCCT should also be considered.

Removal of the existing BCCT center wall will require further structural evaluation to determine if new bracing may be required to provide the lateral support currently provided by the existing wall. Position of new walkways for accessing the proposed dechlorination mixers and cleaning turret platforms should be coordinated with the required spray patterns needed for the new tank cleaning system. Expansion joint replacement and crack repair is also assumed as part of the work to rehabilitate the existing BCCT; an entry inspection into the tank during design phase would serve to define specific rehabilitation needs.

The new chemical storage building is assumed to require a pile supported slab on grade with specific attention given to the chemical storage tanks. Other larger facilities such as valve chambers and large-diameter piping may also require pile supports.

2.9 GEOTECHNICAL / EXCAVATION CONSIDERATIONS

It is a foregone conclusion that the new process tank would be supported on driven piles. The subsurface conditions at the proposed tank are not known through explorations made at the tank location. Borings from the plant and the local geology indicate that the subsurface conditions would be similar at this tank location to the other areas of the plant. Accordingly, for the purposes of this evaluation and costing purposes, the new tank was presumed to be supported on 250-foot long H-piles driven to bear as friction piles in the deep sand layer encountered in the rest of the plant at about elevation 160 feet (about 210 feet below the ground surface). There is a successful history of 100-ton design load 14-inch H-piles for previous projects at this site. Bare HP14x73 H-piles have been used on some projects; HP14x73 coal tar epoxy corrosion resistance coated piles were used on other projects; and heavier HP14x89 were used on other projects to provide similar design loads, but with a sacrificial thickness for potential long-term corrosion loss.

The NYS Building Code changed in or about 2007 to require seismic design provisions. Review of the plant history did not indicate significant projects beginning construction after this date. Since this project would require seismic evaluation of the subsurface to conform with the building codes, it would differ from the previous projects.

The upper sand layer, encountered in Boring 314U (1974) from about elevations 335 feet to 360 feet, was not a focus of previous exploration work, and has not been characterized adequately for seismic design work.

This layer was not significant for pile-supported facilities in the past that did not have seismic design requirements. The 25-foot thick loose sand layer is a potentially liquefiable layer subject to loss of strength during the design earthquake. According to the building codes, the new process tank would be located in an area of F seismic soil profile. A site-specific response analysis will be necessary to determine the seismic design parameters for the new process tankage. The site-specific response analysis would be performed according to relatively standard procedures using the computer model SHAKE, or a similar model. Although there are many subtleties of the analysis that could result in differing results from various models, the differences may be unimportant. If the layer does have the potential for liquefaction during the design earthquake, an additional pile design requirement would be necessary wherein the piles must be designed to withstand potential buckling if laterally unsupported by soil during a liquefaction event.

To evaluate the seismic design, new test borings must be drilled for the proposed structures with the objective of characterizing the liquefaction susceptibility of the sand layer from elevation 335 feet to elevation 360 feet. It is advisable to extend at least two borings down to a minimum 250-foot depth to provide information for bidding the driven piles. It is possible that the sand bearing layer encountered throughout the rest of the plant is shallower or deeper at the proposed structures location.

The tank construction is anticipated to require an excavation to about elevation 352 feet. Such a deep excavation is similar to other excavations made at the plant in the past. It would require special soil dewatering measures to lower the water table about 15 feet. This has been done in the past with well points and with open drainage. Well points may be more appropriate for this size project. Dewatering work may also lower the water table nearby. The effects need to be studied of the potential water table lowering on potential settlement of nearby facilities. Special measures may be required to limit the extent of the water table drawdown. WEP indicated that there have been settlement concerns along the west side of the aeration tanks; therefore, evaluations should include an analysis of avoiding additional influences. At this point, it is not known if the existing pile supported tanks and conveyances may be significantly affected by the dewatering over a relatively short construction time frame.

Detailed design should consider the tank being constructed in a sheeted excavation because of space limitations for open cutting. The excavation would need to be about 35 feet wider if an open cut were used. Sheeting also provides a seepage cutoff that will reduce the extent of water table drawdown and potential settlement of nearby facilities.

To provide a stable base for construction and pile driving, the excavation should be undercut a minimum of 3-feet below the tank bottom and a subbase of crushed stone placed to support pile driving equipment. For a tank with bottom level at about elevation 357.5 feet, with a 2-foot thick base slab and 3-foot thick stone subbase, the excavation bottom would be at approximately elevation 352.5 feet.

The excavation would be about 20 feet below elevation 372.5 feet. This excavation would be too deep for cantilever sheet piling. The sheet piles would require bracing in the form of tieback anchors, deadman anchors or internal bracing. Deadman anchors would probably be the most appropriate bracing in combination with a shallow precut to lower the existing grade a few feet before excavating. The subbase course in the bottom should be placed as the excavation is made to limit the effective height of the sheeting and to protect the subgrade from softening that would reduce stability for construction. If the effects of dewatering on the surrounding facilities can be accepted, open cut excavation may be used against the existing aeration tanks, otherwise sheet piling could be used to limit the extent of the dewatering drawdown.

A minimum of three additional approximately 45-foot-deep test borings are required to be drilled between the proposed facilities and the railroad tracks to evaluate the ground conditions for design of the excavation shoring and to provide the basis for confirming stability of the railroad embankment and water transmission main to the west.

2.10 RAILROAD REQUIREMENTS

The nearby facilities that could be affected by the construction include the railroad and OCWA transmission main along the base of the tracks. These facilities are both sensitive to potential settlement and ground movement due to excavation activities. Ground movement could occur potentially from water table depression from dewatering or from instability. An initial slope stability analysis was performed based on soil properties estimated from previous work at the plant and found an acceptable safety factor for the proposed excavation with respect to the railroad (with surcharge load) and OCWA transmission main. The sheeting would generally be set back far enough from the railroad to avoid the theoretical embankment zone extending up to the track level as defined by AREA. Space would also have to be provided to allow deadman anchors to be installed between the sheeting and the railroad property. A cross-section showing the new tank horizontal and vertical relationship with the railroad is shown on Figure 3.

The steel sheet piling along the west side of the structure(s) may be driven below the theoretical embankment line of the railroad. An evaluation will be required to determine if the steel sheet pile wall should be left-in-place, or if it can be removed. The additional cost of leaving steel sheet piling in place could be substantial for this project. Usually sheet piles below the theoretical embankment line must be left in place. Nevertheless, only a small portion of the sheeting will be installed below the theoretical embankment line, so an evaluation may determine that the sheets could be removed. Along the other three sides of the excavations, removal of the sheeting could be considered as long as the nearby facilities are all supported on long piles. Sheet pile extraction has a risk of causing ground settlement from shifting and densification of the soft and loose soils. If the ground settlement would be objectionable for facilities or operations, the sheets should be left in place.

As a construction concern, measures would be required to ensure that cranes and pile driving equipment are set back far enough to avoid the potential for falling across the tracks. This could be a significant consideration for tall cranes with long leads for pile driving. Boom length may need to be limited, or flagman and contingency measures may be required to address this rail safety concern.

3.0 ALTERNATIVE B – REUSE OF ABANDONED TERTIARY CLARIFIERS

Reuse of the existing tertiary clarifiers has been discussed by WEP staff since the tanks were decommissioned in 2005. Initial "back of the envelope" comparative cost estimates suggested the potential for retrofitting and reusing the tertiary clarifiers at a cost competitive to that of new process tankage. However, a number of significant cost and feasibility risks (unknown information) were identified that could result in a substantially different outcome, including:

- The need for pumping secondary bypass into the tertiary tanks instead of gravity flow
- Structural rehabilitation of the tertiary tanks, which were constructed in the 1950s

- The impact of fill and draw operation on the soft souls underlying the tertiary tanks, which are not pile supported
- Need to upgrade the existing Tertiary Pump Station

The following sections summarize the detailed findings of assessing reuse of the abandoned tertiary clarifiers, including the above concerns.

3.1 STRUCTURAL INSPECTION

As the existing tanks were constructed in the 1950s, a structural condition assessment was performed to determine the practicality of reusing the clarifiers to handle bypass flows. A visual inspection of interior and above-grade exterior surfaces of Tertiary Tank No. 1 was performed, along with a cursory inspection of the above-grade exterior surfaces of Tanks 2 through 6. Concrete cores were also obtained from the floor of Tank No. 1. Cores were not taken from the tank walls because the clarifier was found to be of wire wound construction with a gunite covering; cutting the wire winding could damage the tank wall. A bulleted summary of the findings discussed is presented below:

- The floor slab of Tank No. 1 shows some deterioration and leakage, and would require joint repair prior to reuse.
- The interior walls of Tank No. 1 show minor cracking and a few active leaks, which would require repair prior to reuse.
- Sounding tests did not reveal hollow sounding areas on the interior of Tank No. 1; however, the same tests showed possible areas of voids or disbanding between the concrete and reinforcement material in the upper 2 to 3 feet of the tank walls. Sounding of Tanks 2 through 6 showed fewer areas of possible voids or disbanding.
- Multiple tanks exhibit vegetative overgrowth due to inactivity; this vegetation would need to be cleaned and removed prior to reuse of the tanks.
- Compression testing results on three cores obtained from the Tank No. 1 floor yielded an average concrete strength of above 5,000 psi (see Appendix A).
- Petrographic analysis performed on two cores obtained from the Tank No. 1 floor indicated the concrete is in fair to good condition. This is indicative of some deterioration with the over 50-year old tanks (see Appendix A).

Based on the above observations, CRA determined that the existing tanks may be structurally suitable for reuse if joints are repaired, interior damaged areas are resurfaced, and areas of delaminated gunite replaced. However, there are concerns on the pre-stressing wire tendons that provide hoop tension for the tank walls, as their current size, type, and condition were not assessed since they are under a layer of gunite. The wire condition is critical to estimate remaining useful life. Additional inspection is recommended by a tank manufacturer such as NDTanks, if tank reuse is considered any further.

3.2 TANK REUSE FLOW PROCESS

The most significant treatment benefit of reusing the tertiary tanks would be the opportunity to readily combine secondary and tertiary bypass flow streams into a single disinfection and dechlorination process.

The presence of 6 MG of existing on-site tankage also offers a further ancillary reduction in bypass volumes and phosphorus discharges. Two options to reuse the tanks were evaluated. Option 1 involves the tanks flowing in two parallel groups of three tanks, as currently configured. Option 2 consists of rearranging the tank influent piping such that the tanks flowed in series. With Option 2, reuse of only three tanks was considered because only three tanks would be necessary for providing 2.8 MG of process tankage to accomplish disinfection and dechlorination.

Under both reuse options, bypass flow would be collected at the existing secondary bypass launders and rerouted into Big Blue via 60-inch piping interconnections. It was assumed that the new interconnections would use a 60-inch tee connection within the existing main effluent gallery, and would require a large roof penetration and significant piping renovations. This new interconnection would allow Big Blue to route all bypass flow to the Tertiary Pump Station wet well.

The SEPS bypasses cannot flow by gravity into the tertiary tanks. Therefore, the Tertiary Pump Station would need to be rehabilitated to pump flow into the tanks. This work would involve either rebuilding or replacing the existing pump-motor assemblies. Rebuilding the existing pumps would require new alternating current (AC) motors to replace the existing direct current (DC) units, as well as retrofitting with new variable frequency drives (VFDs). Full replacement and upgraded station capacity would also be considered, with three new 60-mgd rated pumps installed with VFDs; this approach would provide for redundant pump operation. The Tertiary Pump Station would also be retrofitted with a new sodium hypochlorite feed system to dose disinfectant upstream of the existing tertiary tanks.

3.2.1 REUSE OPTION 1 – TANKS 1 - 3 STORAGE AND TANKS 4 - 6 TREATMENT

Option 1 for reuse of the existing tertiary tanks assumed using the "A" side tanks (Nos. 1 through 3) to serve as storage of bypass flow only, while the "B" side tanks (Nos. 4 through 6) would be used for bypass treatment (see Figure 4). Storage in the A tanks would serve to contain the "first flush" of a wet weather event, with B tanks activating once the A-side tanks are filled to capacity.

The A tanks, once cleaned and refurbished, would provide approximately 3 MG of storage volume for bypass flow. Reuse of these tanks would require refurbishment or replacement of an existing control valve within the main pipe gallery to close off flow to the A side once the tanks are filled to capacity, at which time the B side would begin to receive flow. The A side outlet launders would be removed and the effluent piping abandoned.

The B tanks, once cleaned and refurbished, would operate in parallel in keeping with the current pipe configuration. The influent piping would have twice the flow than what they were originally designed for which would add headloss and require raising of the flow control structure weirs. The tanks could be retrofitted with intermediate weir walls to create a disinfection and dechlorination zone in each tank; however, this would be complex to operate in three separate tanks. Therefore, dechlorination would occur within the existing BCCT. A new tertiary tank effluent pipe would be required to carry overflow to the existing bypass tank for dechlorination and discharging to Outfall 002. The new effluent pipe would be 72 inches in diameter, and would pass under Outfall 001 using an inverted siphon.

Under this option, each of the existing tanks would require removal of the existing mechanical scraper assemblies. Removal of settled solids within the refurbished tanks could be accomplished using the existing piping network within the tertiary flow control structures. The condition of the existing 6-inch sludge suction pipes is a concern reported by Metro staff. Therefore, the piping would need to be inspected to see if it is suitable for reuse. Replacement of piping under the tank flow would be costly and could compromise the tank floor. The existing sludge pumps inside each control structure would require replacement.

Clean-in-place systems similar to the flushing gate arrangements identified for the new process tankage option were investigated; however, these systems are designed to move sludge outward to a collection trench at the circumference of the tank floor, which would require significant modifications to the existing tanks, which are sloped towards the center. To avoid such structural modifications, a manually-operated pressure water-based system would be considered, utilizing the existing tank sumps for sludge removal. This is a significant operational concern for Metro staff. Bypass flow stored by the tanks would need to be drained back into the primary system at the conclusion of a bypass event. The sludge pumps would take too long to dewater the tanks following a bypass event. This would require a new submersible pumping station. A new dewatering force main would be required to route flow back to the WWTP's primary treatment train.

Another significant concern with Option 1 involves the elevation of the existing tertiary tank effluent weirs, as the weir for Tank No. 5 (tank that has settled most) is at an elevation lower than the existing BCCT discharge weir elevation. Assuming even a marginal headloss within the effluent piping, the existing BCCT discharge weir elevation would need to be lowered to overcome the headloss. This could compromise the WWTP's protection from maximum lake level conditions.

3.2.2 REUSE OPTION 2 - TANKS 1 - 3 IN SERIES FOR TREATMENT

Option 2 for reuse of the existing tertiary tanks involves only the A tanks (Nos. 1 through 3) for use in bypass treatment (see Figure 5). The A-side tanks would operate in series to handle the bypass flow, which requires reconfiguring the influent piping so that the three A-side tanks would flow in series. This option does not offer the additional 3 MG of flow capture that is part of Option 1. Tank 1 would receive the initial bypass event loading, and would overflow to Tank 3, which in turn would overflow to Tank 2. The effluent from Tank 2 could discharge into Outfall 001 as currently configured for the existing tertiary system. As an alternative, the Option 2 effluent could also be conveyed to the existing BCCT via new 72-inch diameter pipe and discharged to Outfall 002 as discussed above. This piping would need to be constructed under the chemical gallery which adds complexity and cost.

Because the abandoned tertiary system feed piping was not designed to handle the full bypass flow rate through each tank, the new interconnecting piping required to operate the tanks in series would be much larger in diameter than the existing tank influent pipes. New 72-inch diameter pipes would be required to handle the series bypass flow into each tank. Discussions with NDTanks indicated that a pipe penetration of this size through the pre-stressed tank wall would not be feasible; therefore, new piping would need to be brought in under the tank floor. To address potential short circuiting, the influent piping would be routed to the center of each tank. Tank 2 would be retrofitted with an intermediate weir to create a new dechlorination chamber. To facilitate this, a sodium bisulfite dosing piping would be installed adjacent to Tank 2. It is noteworthy that potential freezing of the influent and chemical piping would need to be considered.

A permanent cleaning system similar to Option 1 would be required in each of the three tanks. Sludge suction piping would need to be evaluated before reuse as there is a concern of pipe age and that tank settling may have damaged the pipe.

3.3 TANK SETTLEMENT

The geotechnical aspects of the existing tertiary tanks were evaluated. Based on previous data and a survey conducted for this project, it appears that the tanks have settled between about 1 and 4 feet since their construction in 1958. Tanks 4, 5, and 6 have settled between approximately 3.5 and 4.5 feet; Tanks 2 and 3 have settled between about 2 and 3 feet; and Tank 1 approximately 0.5 foot. There are indications of repairs of the tanks to mitigate the effects of differential settlement. The tanks have been unloaded for several years and appear to be essentially stable in the unloaded condition. For this evaluation, it was presumed that the tanks were essentially filled and in service from about 1960 until 2006 and have since been empty.

Based on the settlement records and the subsurface conditions, it is estimated that if the tanks are put back into service, they will continue to settle at a slow rate. The tanks that have settled the most would be expected to continue to settle the most in the future. Extrapolation of the settlement records indicates a likelihood that the tanks could continue to settle at a rate of 1 to 2 feet per log cycle of time with respect to beginning in May 1959. Accordingly, the tanks would be expected to settle as much as 2 to 4 inches if left in service full time for the next 25 years. If left filled only 30 percent of the time, the settlement values may be reduced to up to 30 percent of the estimated values. Due to the uncertainties of extrapolating old data and loading conditions from 50 years past to 25 years in the future, the tanks should be evaluated based on future settlement being on the order of 2 to 4 inches.

In addition, these tanks, which are not supported on piles, could be vulnerable to sudden shifting from liquefaction during the design earthquake or from seismically induced ground settlement. Previous evaluations for the plant did not raise this concern, but potential seismic effects must be considered because they are part of the current code. During the design earthquake, several inches of settlement could occur.

The ground beneath the tanks is not expected to swell and heave when the tanks are unloaded. Nevertheless, the full tank load is substantial and subgrade settlement has been non-uniform. It is suspected that full loading could warp the tanks in an elastic way that could be recovered as a "bounce-back" on unloading. This behavior is not expected to be the result of a significant rebound of the soil, only the tank.

3.4 SUMMARY

Based on the detailed analysis conducted for this project, a number of cost risks, operational challenges, and other concerns associated with reusing the tanks were identified, in particular:

1. There would be high risk of extra costs associated with unknown conditions found during retrofit of the tertiary tanks. Such conditions could include unforeseen structural degradation and interconnecting pipe damage.

2. New tanks can be engineered to minimize cost risks and maximize Operational and Maintenance (O&M) flexibility, while the existing tanks' O&M requirements would not be as flexible.

3. Life expectancy of the existing tanks would be shorter than a new tank. The existing tanks are over 50 years old. The typical design life for wastewater works structures is typically 50 to 75 years. While the potential exists for these tanks to last another 25 to 50 years, new tanks would have a substantially longer remaining useful life.

4. Discharge of bypass flow from the tertiary tanks through Outfall 001 would represent a substantial change. A significant portion of the existing secondary bypass flow is discharged 1,600 feet offshore at the lake bed. This flow would now all be discharged on the shoreline at the lake water surface. It is likely that this change would require a full blown Environmental Impact Statement (EIS), which may be controversial and would take significant time and effort to complete. The SPDES Permit also would need to be modified. These efforts would likely extend completion of secondary bypass treatment facilities well beyond the compliance date.

5. In order to avoid an EIS, bypass effluent piping would need to be constructed underneath Outfall 001, using an inverted siphon, in order to discharge bypasses to Outfall 002. In addition to cost, the inverted siphon would need to be routinely cleaned because of the likely occurrence of solids settling within the pipe between wet weather events.

6. Continued settlement of the tertiary tanks is expected, which may result in warping/damage to the existing and proposed interconnecting piping. Sudden additional settlement could occur as a consequence of the design earthquake.

7. The tertiary tanks have settled unevenly over the years. All have tilted 6 inches or more from one side to the other, which complicates equalization of flow distribution. Significant tank modifications are required to alleviate this condition.

8. Underground piping connections to the tertiary tanks are suspect. Existing drawings show flexible joints, but the condition and presence of these is not known.

9. The record drawings of the existing tanks show cast-in-place construction but the tanks are actually pre-stressed wire wound gunite construction. Because this is such a significant difference, there is concern that additional unknowns are present, particularly the condition of the windings. Also, the original construction submittals do not appear to be available.

10. Retrofit of a sludge removal and clean-in-place system into the tertiary tanks would be extensive and not provide an optimal cleaning system.

11. Sludge removal piping under the bottom of the tertiary tanks is suspect. Therefore, it may need to be replaced by cutting the tank bottom, or a new submersible sludge pumping station would be needed inside each tank.

12. New penetrations through the sidewall of the existing tanks must be small diameter due to the type of construction (wire wound tanks). This limits what can be done for new piping connections.

Based on the above risks, it was decided that reuse of the existing tertiary clarifiers was not feasible. Therefore, this alternative was not evaluated further.

4.0 TERTIARY BYPASS DISINFECTION OPTIONS

The proposed draft permit for the Metro WWTP includes a requirement for disinfection of tertiary bypasses in the future. The draft permit suggests disinfection would be required on all flows greater than the SEPS pump capacity (approximately 126 mgd) up to a peak plant capacity of 240 mgd. If this is the case, the tertiary bypass disinfection system would need to be designed to treat flows up to approximately 114 mgd. WEP has indicated that in most cases the tertiary bypass event volumes and flow rates are small, unless the tertiary process has a planned shutdown which would likely be scheduled outside of the disinfection season.

Historical records for peak tertiary bypass flow rates were reviewed to obtain a better understanding of the treatment efficiency of the proposed alternative described above. WEP provided flow data for five different high volume events between 2005 and 2012. During three of these five events, the minute-by-minute flow rates exceeded 30 mgd.

Disinfection within Big Blue

The potential to disinfect tertiary bypass flows within Big Blue between the SEPS wet well and Outfall 001A was evaluated. At 84 inches in diameter and approximately 1,100 linear feet in length, the volume of Big Blue is approximately 320,000 gallons. Assuming chlorine dosing occurs at the head end of Big Blue, the pipe volume could provide 15 minutes of contact time for a maximum flow rate of 30 mgd. New effluent launders could be constructed within the SEPS wet well to hydraulically isolate tertiary bypass disinfection from the tertiary treatment process. Preliminary calculations show that five 30-foot long launders would add less than 6 inches of water level in the SEPS wet well at peak bypass flows of 114 mgd. This option would eliminate secondary effluent water from the tertiary wet well; therefore, WEP would no longer have access to secondary effluent water in the Plant Operations Building.

Pumping to Bypass Chlorine Contact Tank

Treatment of the full range of tertiary bypass flow (up to 114 mgd) could be accomplished by pumping to the new bypass process tankage discussed above. The existing tertiary pump station could be used for this purpose along with a new force main to the new bypass tank. The tertiary pump station would require refurbishment and/or replacement of pumps and starters if this were considered.

Modifying Secondary Bypass Weirs

Modifying the secondary bypass weirs such that unplanned tertiary bypasses no longer occur is the preferred method of mitigating the need for a new tertiary bypass disinfection system. The addition of a sluice gate at each of the secondary bypass locations could be used to reduce the hydraulic grade within the tertiary pump station wet well by diverting flow to the bypass tank during times of reduced tertiary hydraulic capacity, thereby eliminating tertiary bypasses. A 36-inch by 36-inch gate would have the capacity to divert about 50 mgd (per train) during peak hydraulic grade conditions with the new bypass tank. Figure 6 shows how the gates would be installed within the secondary bypass overflow chamber at the aeration tanks. The gates would be normally closed and opened incrementally in relation to the desired water level in the tertiary pump station wet well.

5.0 PRELIMINARY COST ESTIMATE

Preliminary capital costs for the recommended bypass disinfection improvements are estimated at approximately $20.2 million (2016 dollars). This includes a 25 percent construction contingency allowance and an allowance of 20 percent for engineering, legal, and administration fees. The estimate is based on costs for similar components at other facilities, equipment vendor estimates, and engineering judgment. Improvements for secondary bypass disinfection include a new 2-MG process tank, dewatering pump station, tank cleaning systems, chemical treatment equipment, chemical storage building and unloading area, and modifications of the existing BCCT. The estimate includes approximately $250,000 in improvements for rerouting of tertiary bypasses to the secondary bypass process tankage with use of two new motorized sluice gates. Tertiary bypass improvements are not currently a SPDES Permit condition; therefore, this work may not need to be completed at the same time as the secondary bypass disinfection improvements.

6.0 PRELIMINARY SCHEDULE

According to Metro's current SPDES Permit, compliance with the new Outfall 002 fecal coliform and total residual chlorine limits must be achieved by April 1, 2016. Construction would likely require a minimum of 18 months and possibly up to 24 months for completion. Considering the extensive effort necessary to design and construct these facilities, it is recommended that WEP proceed with this project as soon as practical. The anticipated key milestones (assuming an 18-month construction period) to implement the secondary bypass disinfection and dechlorination system improvements are as follows:

• Retain Consultant	May 2013
• Complete Preliminary Design and NYSDEC Approval	November 2013
• Complete Detailed Design and NYSDEC Approval	September 2014
• Complete Bid/Award	December 2014
• Complete Construction	April 1, 2016

Note that some reduction in schedule may be possible depending upon expedited NYSDEC and permitting reviews and accelerating the design process.

Attachment 1: Figures
- Figure 1 - Site Plan of Proposed Disinfection Improvements
- Figure 2 - Conceptual Layout of Proposed Disinfection Improvements
- Figure 3 - Partial Cross Section of Proposed Tank Installation
- Figure 4 - Tertiary Tank Reuse Option 1 - Tanks 1-3 Storage and Tanks 4-6 Treatment
- Figure 5 - Tertiary Tank Reuse Option 2 - Three Tanks in Series
- Figure 6 - Tertiary Bypass Hydraulic Grade Control Gate

Attachment 2: Preliminary Project Cost Estimate

Attachment 3: Appendix A - Tertiary Tank Concrete Compression and Petrographic Testing Results

ATTACHMENT 1

FIGURES

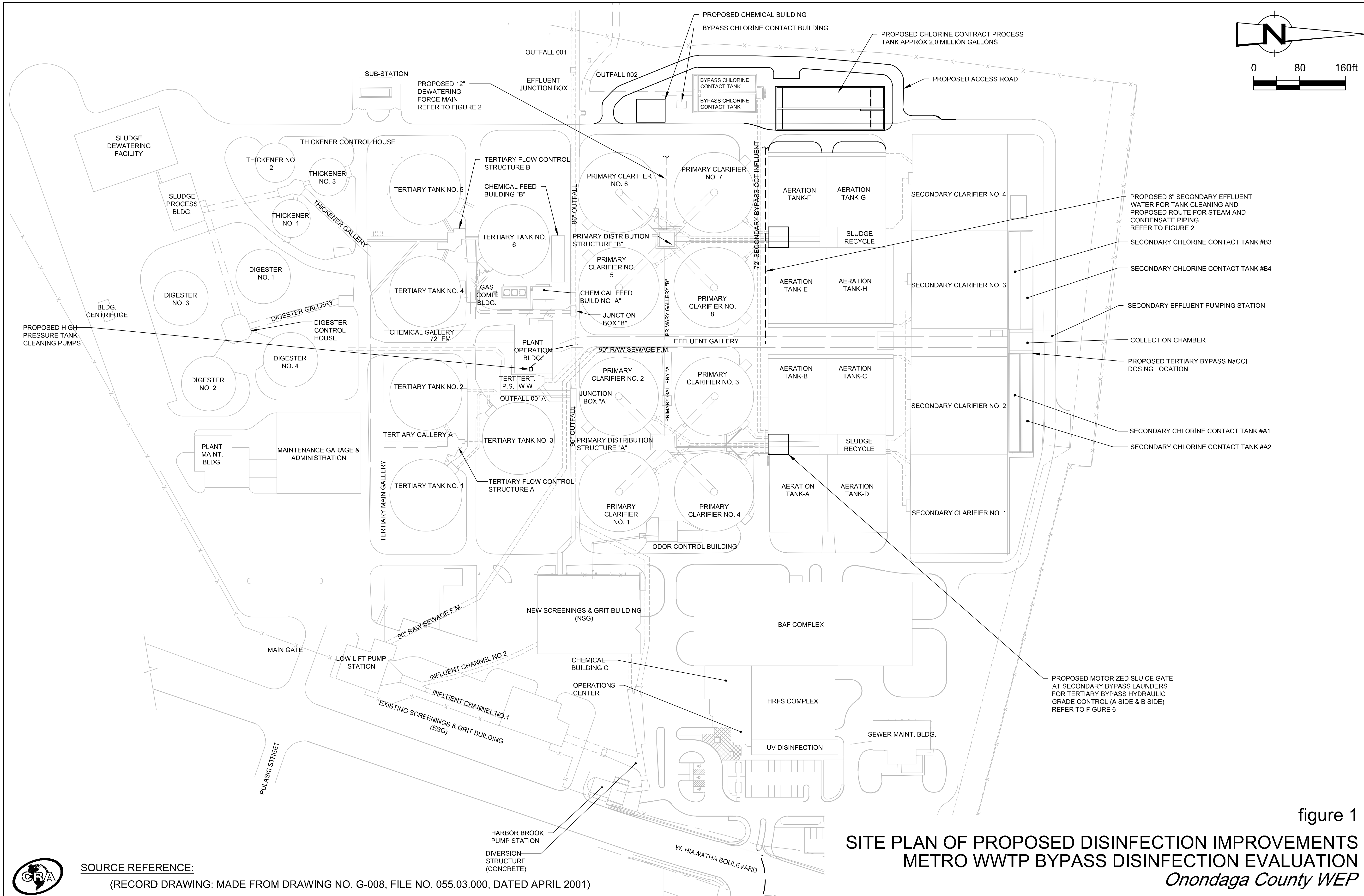
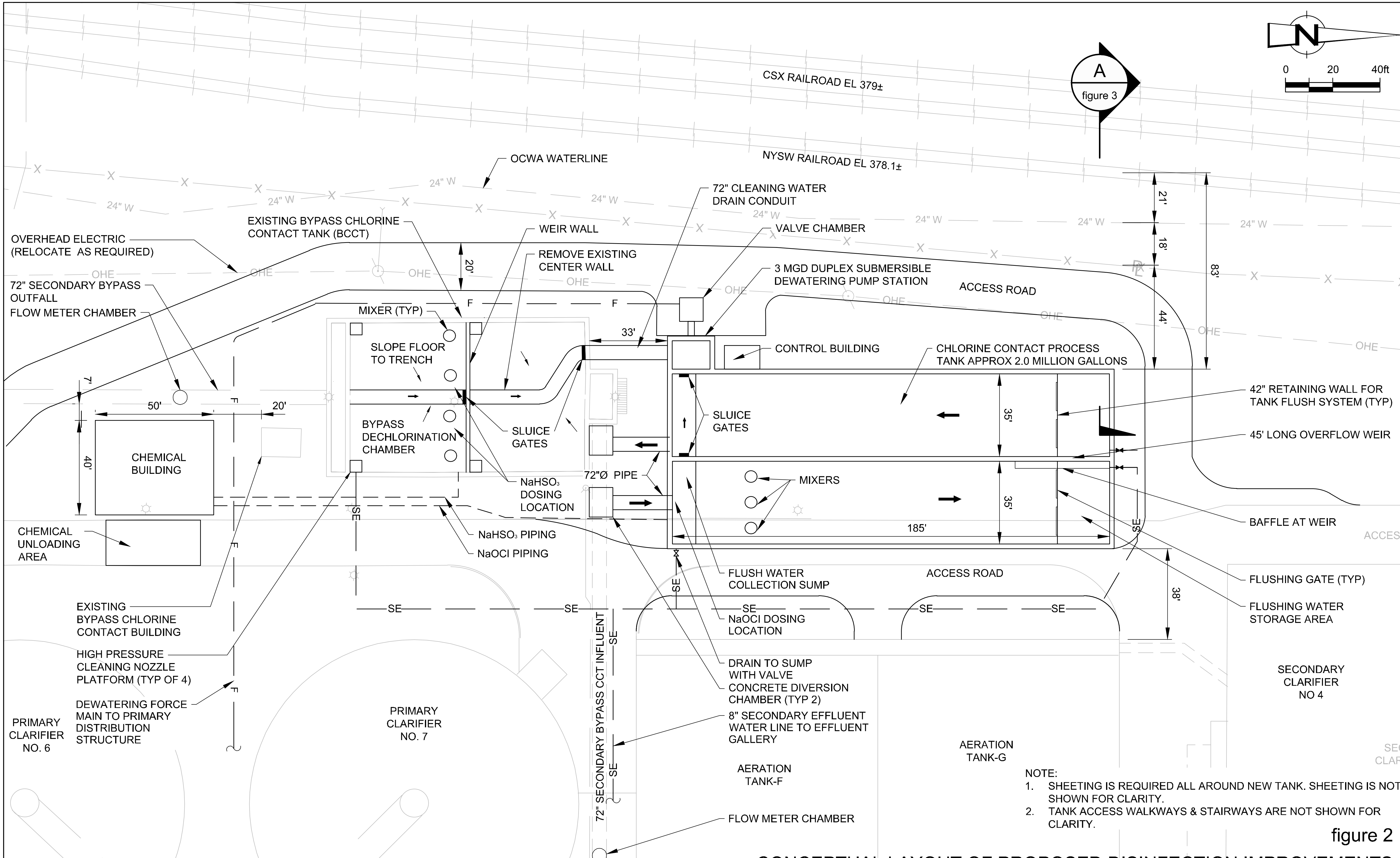


figure 1

SITE PLAN OF PROPOSED DISINFECTION IMPROVEMENTS
METRO WWTP BYPASS DISINFECTION EVALUATION
Onondaga County WEP

630812-08(MEMO003)GN-BU001 MAR 28/2013



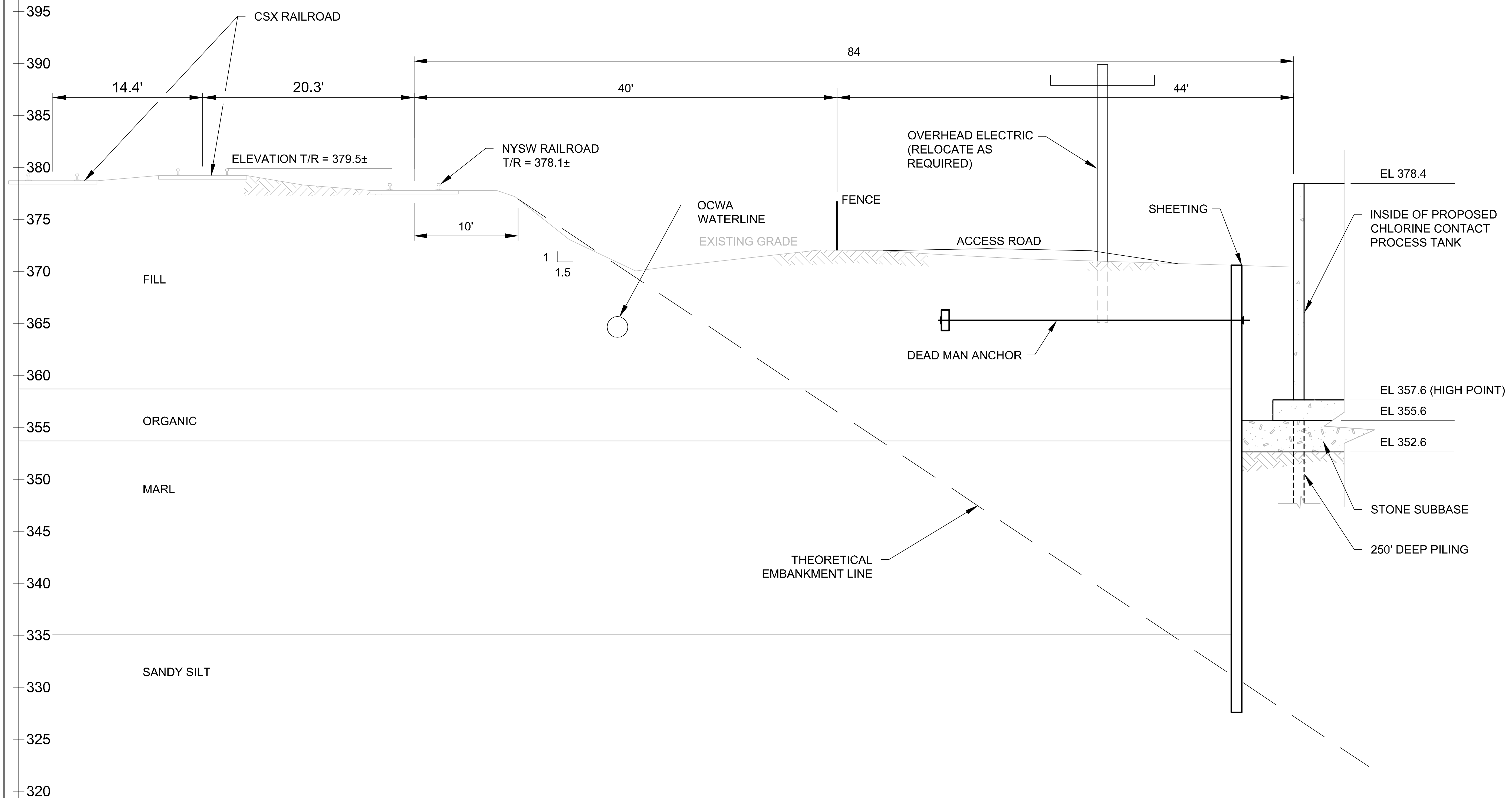
NOTE:
1. SHEETING IS REQUIRED ALL AROUND NEW TANK. SHEETING IS NOT SHOWN FOR CLARITY.
2. TANK ACCESS WALKWAYS & STAIRWAYS ARE NOT SHOWN FOR CLARITY.

figure 2

CONCEPTUAL LAYOUT OF PROPOSED DISINFECTION IMPROVEMENTS
METRO WWTP BYPASS DISINFECTION EVALUATION
Onondaga County WEP

SOURCE REFERENCE:
(RECORD DRAWING: MADE FROM DRAWING NO. G-008, FILE NO. 055.03.000, DATED APRIL 2001)
UPDATED BASED ON TOPOGRAPHIC SURVEY PERFORMED BY CRA ON JANUARY 4, 2013

630812-08(MEMO003)GN-BU002 MAR 27/2013



SOILS INFORMATION BASED ON HISTORICAL DATA. INFORMATION MUST BE UPDATED DURING DESIGN PHASE.
BASED ON TOPOGRAPHIC SURVEY PERFORMED BY CRA ON JANUARY 4, 2013.

figure 3

SECTION A
1" = 10'
figure 2

PARTIAL CROSS SECTION
OF PROPOSED TANK INSTALLATION
METRO WWTP BYPASS DISINFECTION EVALUATION
Onondaga County WEP

630812-08(MEMO003)GN-BU009 MAR 21/2013

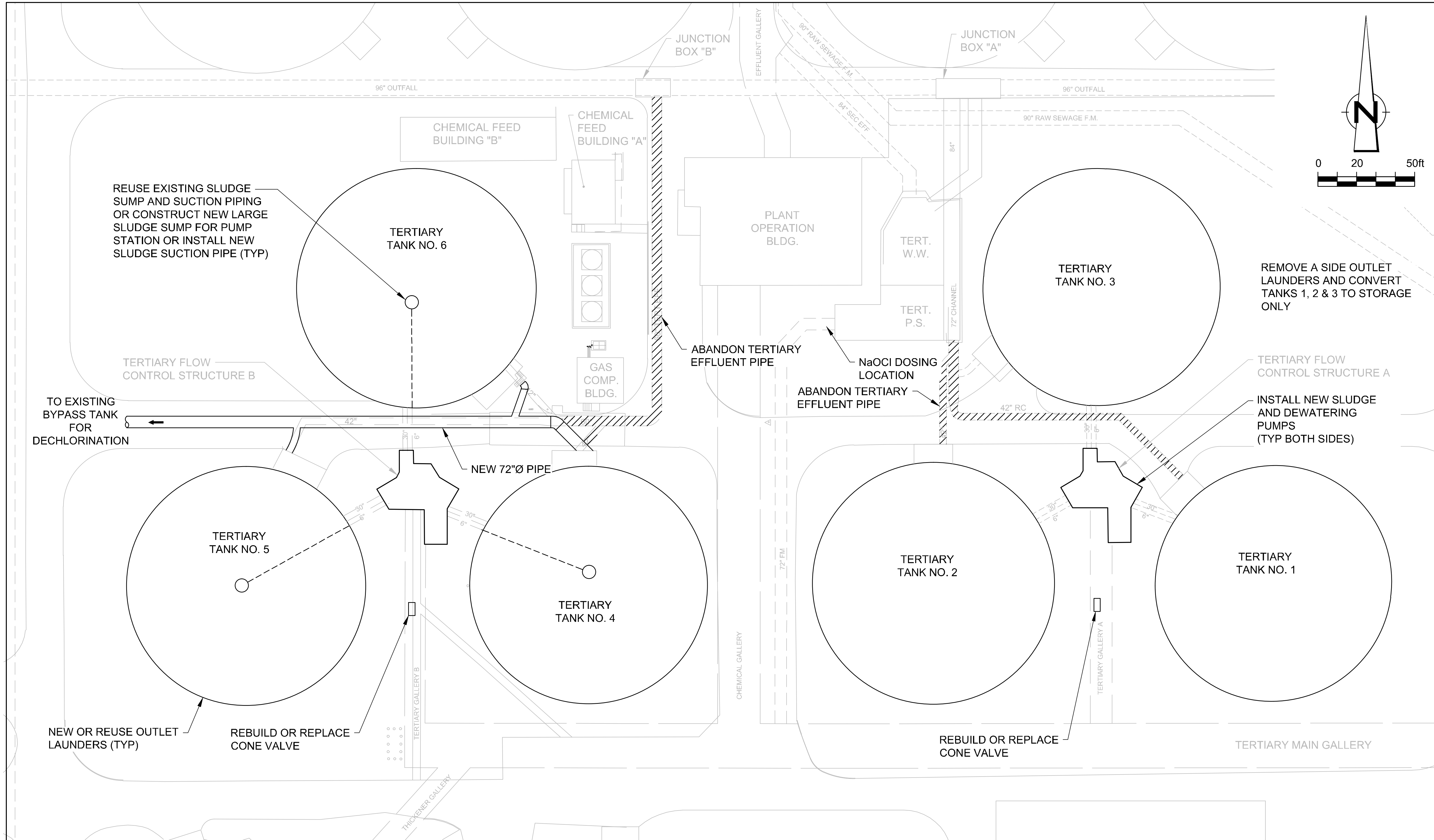


figure 4

TERTIARY TANK REUSE OPTION 1 - TANKS 1-3 STORAGE AND TANKS 4-6 TREATMENT
METRO WWTP BYPASS DISINFECTION EVALUATION
Onondaga County WEP

SOURCE REFERENCE:
(RECORD DRAWING: MADE FROM DRAWING NO. G-008, FILE NO. 055.03.000, DATED APRIL 2001)

630812-08(MEMO003)GN-BU007 MAR 21/2013

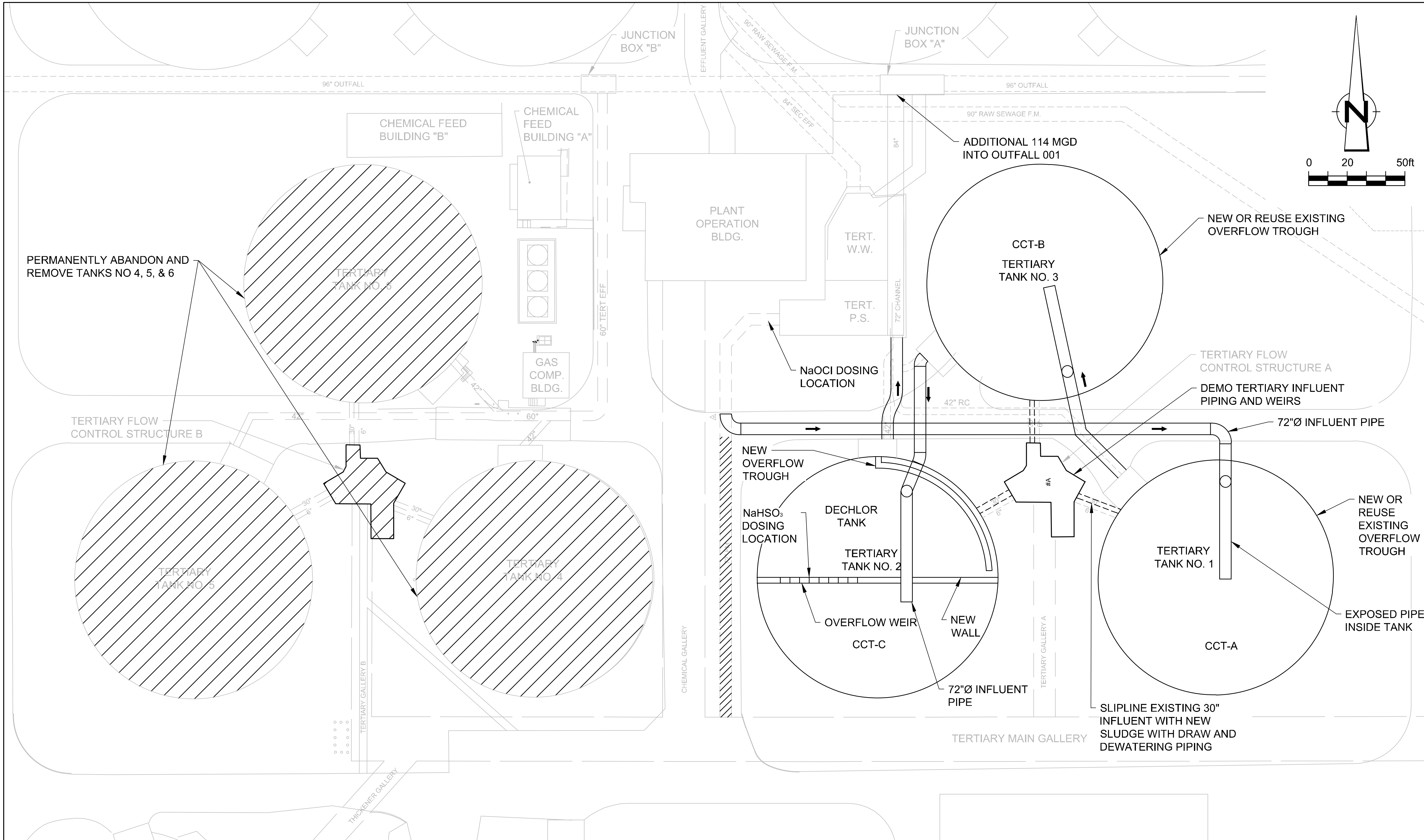
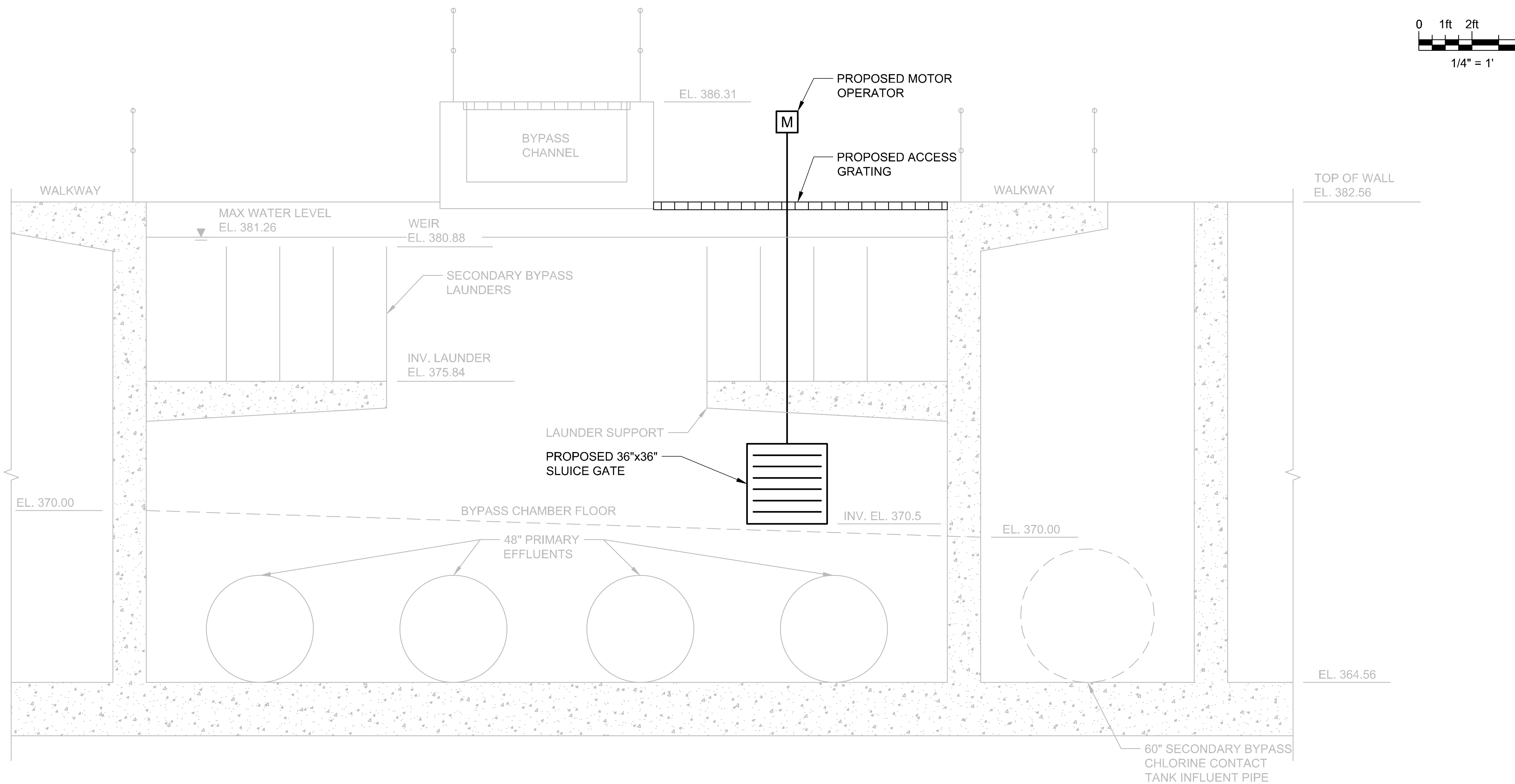


figure 5

TERTIARY TANK REUSE OPTION 2 - THREE TANKS IN SERIES
METRO WWTP BYPASS DISINFECTION EVALUATION
Onondaga County WEP

SOURCE REFERENCE:
(RECORD DRAWING: MADE FROM DRAWING NO. G-008, FILE NO. 055.03.000, DATED APRIL 2001)

630812-08(MEMO003)GN-BU004 MAR 21/2013



SECTION LOOKING SOUTH AT
SECONDARY BYPASS LAUNDERS

NOTE:
SLUICE GATE INSTALLED ON SOUTH SIDE OF BYPASS CHAMBER WALL.

figure 6

CONCEPTUAL CROSS SECTION
TERTIARY BYPASS HYDRAULIC GRADE CONTROL GATE
METRO WWTP BYPASS DISINFECTION EVALUATION
Onondaga County WEP

630812-08(MEMO003)GN-BU011 MAR 21/2013

ATTACHMENT 2

PRELIMINARY PROJECT COST ESTIMATE

PRELIMINARY PROJECT COST ESTIMATE

(2016 Dollars)

Metro WWTP Bypass Disinfection Evaluation - New Chlorine Contact Tankage

Project No. 630812

SIZING ASSUMPTIONS

	New Tank	
Tank Length	185	*Feet*
Tank Chamber Width	35	*Feet*
Tank Depth	22	*Feet*
Usable Storage Depth (at peak HGL)	20.5	*Feet*
New Tankage Capacity	2.00	*Million Gallons*
New Tankage Chambers	2	*Total*
Existing Bypass Tank Capacity (at peak HGL)	0.80	*Million Gallons*
Average Wall Thickness	1.75	*Feet*
Average Floor Thickness	2	*Feet*
Depth of Piles	250	*Feet*
Spacing of Piles	100	*SF*
Annual Inflation	3.00%	
Total Post-Construction Tankage Volume	2.80	*Million Gallons*

COST ESTIMATES

			Materials		**Labor**		
Description	***Quantity***	***Units***	***Unit Cost***	***Total***	***Unit Cost***	***Total***	***Total Cost***
General							
Site Preparation / Layout	1	LS	5,000	5,000	10,000	10,000	15,000
Temporary Fencing	500	LF	6	3,000	8	4,000	7,000
Excavation Dewatering	1	LS	75,000	75,000	25,000	25,000	100,000
Protection of Existing Rail Lines / Flagman	1	LS	20,000	20,000	20,000	20,000	40,000
Protection of Existing Utilities	1	LS	15,000	15,000	25,000	25,000	40,000
Relocation of Miscellaneous Existing Utilities	1	LS	20,000	20,000	10,000	10,000	30,000
Temporary Acess Road	1	LS	2,000	2,000	5,000	5,000	7,000
Relocation of Existing Overhead Electrical Main	1000	LF	50	50,000	25	25,000	75,000
Construction of Diversion Chambers	100	CY	440	44,000	220	22,000	66,000
72" Interconnecting Piping	100	LF	100	10,000	50	5,000	15,000
Chemical Dosing Piping	300	LF	25	7,500	25	7,500	15,000
12" Dewatering Force Main	500	LF	40	20,000	30	15,000	35,000
Potable Water Supply Piping	1000	LF	20	20,000	25	25,000	45,000
8" Secondary Effluent Water Supply Piping	1200	LF	40	48,000	30	36,000	84,000
Steam Heating System Piping / Improvements	1	LS	40,000	40,000	20,000	20,000	60,000
Secondary Effluent Water Hydrants	2	EA	3,500	7,000	1,500	3,000	10,000
Flow Meter Manhole and Insertion Flow Meter	2	EA	15,000	30,000	7,500	15,000	45,000
Restoration of Disturbed Areas	10000	SF	1	10,000	4	40,000	50,000
Asphalt Drive - Type 3 Base Course	150	TON	100	15,000	30	4,500	19,500
Asphalt Drive - Type 7F3 Top Course	50	TON	110	5,500	30	1,500	7,000
Select Backfill Material	500	CY	20	10,000	5	2,500	12,500
Construction of New Chlorine Contact Tank							
Cast-in-place Concrete	1900	CY	375	712,500	200	380,000	1,092,500
Excavation	19700	CY	15	295,500	10	197,000	492,500
Sheeting Wall Shoring	17200	SF	35	602,000	10	172,000	774,000
Deadman / Tiebacks	1	LS	35,000	35,000	35,000	35,000	70,000
Driving of Piles for Foundation Support	35400	LF	58	2,053,200	35	1,239,000	3,292,200
Stone Sub-base Layer	2000	CY	30	60,000	20	40,000	100,000
Tank Flushing System	1	LS	120,000	120,000	50,000	50,000	170,000
Primary Chamber Mixers	3	EA	15,000	45,000	10,000	30,000	75,000
Wall Sleeve Piping and Valves	2	EA	5,000	10,000	2,000	4,000	14,000
Isolation Sluice Gates	2	EA	30,000	60,000	15,000	30,000	90,000
Steel Grating, Stairways, Walkways, Railings, etc.	1	LS	80,000	80,000	40,000	40,000	120,000

PRELIMINARY PROJECT COST ESTIMATE

(2016 Dollars)

Metro WWTP Bypass Disinfection Evaluation - New Chlorine Contact Tankage

Project No. 630812

COST ESTIMATES

Description	Quantity	Units	Materials Unit Cost	Materials Total	Labor Unit Cost	Labor Total	Total Cost
Conversion of Existing Chlorine Contact Tank							
Equipment Demolition	1	LS	5,000	5,000	10,000	10,000	15,000
Removal of Existing Concrete Dividing Wall	1	LS	10,000	10,000	7,200	7,200	17,200
Installation of New De-Chlorination Weir Wall	1	LS	10,000	10,000	5,000	5,000	15,000
Expansion Joint Replacement and Crack Repair	1	LS	5,000	5,000	5,000	5,000	10,000
Concrete for Floor Sloping to North	120	CY	350	42,000	200	24,000	66,000
De-Chlorination Chamber Mixers	4	EA	12,000	48,000	7,000	28,000	76,000
High Pressure Tank Cleaning Platforms / Nozzles	1	LS	20,000	20,000	10,000	10,000	30,000
High Pressure Cleaning Piping Inside Tank	1	LS	10,000	10,000	5,000	5,000	15,000
Two High Pressure Pumps and Valves in POB	1	LS	45,000	45,000	20,000	20,000	65,000
Isolation Sluice Gates	2	EA	35,000	70,000	18,000	36,000	106,000
Steel Grating, Stairways, Walkways, Railings, etc.	1	LS	40,000	40,000	20,000	20,000	60,000
New Chemical Feed/Storage Facility							
Excavation	450	CY	15	6,750	10	4,500	11,250
Dewatering	1	LS	10,000	10,000	5,000	5,000	15,000
Sheet Piling Shoring	1000	SF	25	25,000	10	10,000	35,000
Driving of Piles for Foundation Support	5000	LF	58	290,000	35	175,000	465,000
Stone Sub-base Layer	150	CY	30	4,500	20	3,000	7,500
Cast-in-place Concrete Foundation	120	CY	375	45,000	200	24,000	69,000
Pre-Engineered Steel Building	1	LS	150,000	150,000	50,000	50,000	200,000
15,000-Gallon Fiberglass Chemical Tank	2	EA	30,000	60,000	15,000	30,000	90,000
4,000-Gallon Fiberglass Chemical Tank	2	EA	10,000	20,000	5,000	10,000	30,000
Sodium Hypochloride Feed Pumps	2	EA	8,000	16,000	4,000	8,000	24,000
Sodium Bisulfite Feed Pumps	2	EA	6,000	12,000	3,000	6,000	18,000
Chemical Dosing Piping	1	LS	15,000	15,000	10,000	10,000	25,000
New Submersible Pumping Station							
Excavation	250	CY	15	3,750	10	2,500	6,250
Dewatering	1	LS	10,000	10,000	5,000	5,000	15,000
Driving of Piles for Foundation Support	700	LF	58	40,600	35	24,500	65,100
Stone Sub-base Layer	30	CY	30	900	20	600	1,500
Cast-in-place Concrete	60	CY	375	22,500	200	12,000	34,500
Pump Station / Valve Chamber Equipment (3 MGD)	1	EA	220,000	220,000	100,000	100,000	320,000
Control Building	1	LS	30,000	30,000	15,000	15,000	45,000
Tertiary Bypass Hydraulic Grade Control Gates							
36" x 36" Motorized Sluice Gates	2	EA	30,000	60,000	15,000	30,000	90,000
Aeration Tank Dewatering / Inspection by WEP	1	LS	5,000	5,000	10,000	10,000	15,000
Wall Opening at Bypass Chamber	2	EA	5,000	10,000	5,000	10,000	20,000
Controls and Electrical Improvements							
Electrical/Control	10%	of sum of all modifications					915,000
Subtotal							***10,060,500***
Mobilization, Bonding, Ins.	8%						805,000
Contractor Profit	20%						2,013,000
Contingency	25%						2,516,000
Construction Subtotal							15,394,500
Engineering, Consulting, & Legal Fees	20%						3,079,000
Total (2013 Dollars)							18,480,000

ESTIMATE (2016 Dollars - Rounded) **$20,200,000**

<u>ATTACHMENT 3</u>

APPENDIX A

TERTIARY TANK CONCRETE COMPRESSION
AND PETROGRAPHIC TESTING RESULTS

REPORT OF CONCRETE TESTING

PROJECT:

TANK BASES
METRO SEWER PLANT, SYRACUSE, NY
CRA ENGINEERING
QISI #0615-12CIV-0371, 07.006904

REPORTED TO:

QUALITY INSPECTION SERVICES, INC.
6730 MYERS ROAD
EAST SYRACUSE, NY 13057

ATTN: BRENDAN MALONEY

APS JOB NO: 10-07802

DATE: FEBRUARY 5, 2013

INTRODUCTION

This report presents the results of laboratory work performed by our firm on two concrete core samples submitted to us by Brendan Maloney of Quality Inspection Services on January 14, 2013. We understand the concrete cores were obtained from an interior concrete sewage plant that is currently under evaluation. The concrete was reportedly placed in the 1960's. The scope of our work was limited to performing petrographic analysis testing to document the overall quality of the concrete.

CONCLUSIONS

Based on our observations, test results, and past experience, our conclusions are as follows:

1. The overall quality of both the inner and outer concrete was fair to good. The cement paste was moderately dense and hard with carbonation up to 5/32". The crushed carbonate aggregate (6-inner concrete) was relatively hard, appeared sound, and durable. The concrete was not purposefully air entrained and was placed with a moderate slump.

SAMPLE IDENTIFICATION

Sample Number:	5-outer concrete	6-inner concrete
Sample Type:	Hardened Concrete Core	
Original Sample Dimensions, in:	70 mm (2-3/4") diameter x 165 mm (6-1/2") long	70 mm (2-3/4") diameter x 213 mm (8-3/8") long

TEST RESULTS

Our complete petrographic analysis test results appear on the attached sheets entitled 00 LAB 001 "Petrographic Examination of Hardened Concrete, ASTM C856." A brief summary of the general concrete properties is as follows:

1. The coarse aggregate in the cores was comprised of 1" maximum sized crushed carbonate that was fairly well graded with good overall uniform distribution.

2. Pozzolanic admixtures were not observed in either concrete sample.

3. The paste color of the cores was light to medium gray with the slump estimated to be medium (3 to 5").

4. The paste hardness of the cores was judged to be medium to hard with the paste/aggregate bond considered fair to good.

5. The depth of carbonation was up to 5/32".

6. The water/cement ratio of the cores was estimated at between 0.43 to 0.50 with approximately 1-3% unhydrated cement particles.

Air Content Testing

Sample Identification:	5-outer concrete	6-inner concrete
Total Air Analysis -		
Air Void Content, %	4.3	2.7
Spacing Factor, in.	0.028	0.064
Entrapped Air (%)	1.1	1.8
Entrained Air (%)	3.2	0.9

TEST PROCEDURES

Laboratory testing was performed on January 14, 2013 and subsequent dates. Our procedures were as follows:

Petrographic Analysis

A petrographic analysis was performed in accordance with APS Standard Operating Procedure 00 LAB 001, "Petrographic Examination of Hardened Concrete," ASTM C856-latest revision. The petrographic analysis consisted of reviewing cement paste and aggregate qualities on a whole basis as well as on a cut/polished section. The depth of carbonation was documented using a phenolphthalein indicator solution applied on a freshly cut and polished surface of the concrete sample. The water/cement ratio of the concrete was estimated by viewing a thin section of the concrete under an Olympus BH-2 polarizing microscope at magnification up to 1000x. Thin section analysis was performed in accordance with APS Standard Operating Procedure 00 LAB 013, "Determining the Water/Cement of Portland Cement Concrete, APS Method." The samples are first highly polished, then epoxied to a glass slide. The excess sample is cut from the glass and the slide is polished until the concrete reaches 25 microns or less in thickness.

Air Content Testing

Air content testing was performed using APS Standard Operating Procedure 00 LAB 003, "Microscopical Determination of Air Void Content and Parameters of the Air Void System in Hardened Concrete, ASTM C457-latest revision." The linear traverse method was used. The concrete cores were cut perpendicular with respect to the horizontal plane of the concrete as placed and then polished prior to testing.

REMARKS

The test samples will be retained for a period of at least thirty days from the date of this report. Unless further instructions are received by that time, the samples may be discarded. Test results relate only to the items tested. No warranty, express or implied, is made.

Report Prepared By:
American Petrographic Services, Inc.

Scott F. Wolter, P.G.
President
MN License No. 30024
Phone: 651-659-1345
swolter@amengtest.com

00 LAB 001 Petrographic Examination of Hardened Concrete
ASTM C856

Job No.	10-07802	Date:	1-29-2013 / 2-4-13
Sample Identification:	5 – outer concrete	Performed by:	S. Malecha / M. Koch

I. General Observations

1. Sample Dimensions: Our analysis was performed on the approximately 83 mm (3-1/4″) outer concrete of both sides of an approximately 165 mm (6-1/2″) x 64 mm (2-1/2″) x 32 mm (1-1/4″) thick polished section that was cut from the original 70 mm (2-3/4″) diameter x 165 mm (6-1/2″) long core.

2. Surface Conditions:
   Outer: Fairly rough, chemical attacked? medium light brown stained surface
   Inner: Rough, irregular, fractured surface

3. Reinforcement: None observed

4. General Physical Conditions: The concrete core sample consisted of an approximately 89 mm (3-1/2″) thick medium gray inner concrete overlain with approximately 83 mm (3-1/4″) thick medium light gray outer concrete. The sample was fractured, oriented sub-parallel to the outer surface, across the core's diameter proximate to the outer/inner concrete interface. The inner concrete was characterized by its medium gray paste and crushed carbonate coarse aggregate. Many irregular shaped voids and poor distribution of sand was observed within the inner concrete with some concentration proximate to the fracture. The inner concrete appeared not air entrained. The petrographic analysis was limited mostly to the outer concrete. The outer surface of the sample appeared to have undergone chemical attack exposing few fine aggregate particles. The outer approximately 2 mm (1/16″) of the sample was stained medium dark gray and light brown. Few microcracks were present. Carbonation proceeded up to 3 mm (1/8″) depth. The outer concrete contained a small amount of air entrainment. Few irregular shaped voids were observed within the outer concrete. Ettringite was observed. No evidence of active alkali silica reaction observed. Good overall condition.

II. Aggregate

1. Fine: Natural quartz, feldspar, lithic and carbonate sand that was fairly well graded. The grains were mostly sub-rounded with many sub-angular particles. Good overall uniform distribution.

III. Paste

1.	Air Content:	4.3% total. Test performed on the outer concrete.
2.	Paste proportions:	36% to 38%. Test performed on the outer concrete.
3.	Depth of carbonation:	Ranged from negligible to approximately 3 mm (1/8″) depth from the outer surface of the outer concrete. Intermittent carbonation was observed along and proximate to the fracture within the inner concrete.
4.	Paste/aggregate bond:	Fair
5.	Paste color:	Medium light gray in the outer concrete and mottled medium gray to medium light gray in the inner concrete (Munsell® rock color N6 and N5). Similar to medium dark gray and light brown in the outer approximately 2 mm (1/16″) of the outer concrete (Munsell® rock color N4 and 5YR 5/6).
6.	Paste hardness:	Medium (Mohs' scale 2-3) in the outer concrete
7.	Microcracking:	A microcrack, oriented sub-perpendicular to the outer surface, proceeds from the outer surface of the outer concrete to approximately 9 mm (3/8″) depth.
8.	Secondary deposits:	White, acicular ettringite was observed filling few voids and partially filling many other voids scattered throughout the outer and inner concretes. Few microcracks were observed proximate to the outer/inner interface.
9.	Slump:	Estimated, medium (3 to 5")
10.	Pozzolan/Slag presence:	None observed
11.	Water/cement ratio:	Estimated at between 0.45 to 0.50 with approximately 1-3% unhydrated or residual portland cement clinker particles.
12.	Cement hydration:	Alites-fully; Belites-fully

IV. Conclusions

The general overall quality of the concrete was fair to good.

00 LAB 001 Petrographic Examination of Hardened Concrete
ASTM C856

Job No.	10-07802	Date:	1-29-2013 / 2-4-13
Sample Identification:	6 – inner concrete	Performed by:	S. Malecha / M. Koch

I. General Observations

1. Sample Dimensions: Our analysis was performed on the approximately 140 mm (5-13/16″) inner concrete portion of both sides of an approximately 210 mm (8-1/4″) x 67 mm (2-5/8″) x 30 mm (1-3/16″) thick polished section that was cut from the original 70 mm (2-3/4″) diameter x 213 mm (8-3/8″) long core.

2. Surface Conditions:
   Outer: Rough, irregular surface overlain with medium light gray outer concrete
   Inner: Rough, irregular, fractured surface

3. Reinforcement: None observed

4. General Physical Conditions: The concrete core sample consisted of an approximately 140 mm (5-1/2″) thick medium gray inner concrete overlain with approximately 79 mm (3-1/8″) thick medium light gray outer concrete. The outer concrete appeared fairly well bonded to the inner concrete. The outer concrete was characterized by its medium light gray paste with fine aggregate. The outer surface of the outer concrete appeared to have undergone chemical attack exposing many fine aggregate particles. The outer approximately 2 mm (1/16″) to 4 mm (5/32″) of the outer concrete was stained medium dark gray and light brown. Carbonation proceeded up to 4 mm (5/32″) depth. The outer concrete appeared to contain a small amount of air entrainment. Many irregular shaped voids were observed within the outer concrete. The petrographic analysis was limited mostly to the medium gray inner concrete. The sample was fractured, oriented sub-parallel to the outer surface, across the core's diameter within the inner concrete between approximately 8 mm (5/16") and 25 mm (1″) depth from the outer surface of the inner concrete. Few microcracks were present. The inner concrete was not air entrained. Several irregular shaped voids were observed proximate to the fracture within the inner concrete. Ettringite was observed. Evidence of minor alkali silica reaction observed. Fair to good overall condition.

II. Aggregate

1. Coarse: 25 mm (1″) maximum sized crushed carbonate consisting of fossiliferous limestone, dolomitic limestone and argillaceous dolostone. The coarse aggregate was mostly sub-angular with many angular particles. Fairly well graded with good overall uniform distribution.

2. Fine: Natural quartz, feldspar, lithic and carbonate sand with some shale that was fairly well graded. The grains were mostly sub-rounded with many sub-angular particles. Good overall uniform distribution.

III. Paste

1. Air Content: 2.7% total. Test performed on the inner concrete.
2. Paste proportions: 21% to 23%. Test performed on the inner concrete.
3. Depth of carbonation: Intermittent carbonation was observed along and proximate to the fracture within the inner concrete. Carbonation was observed along the perimeter of few coarse aggregate particles. Carbonation ranged from approximately 2 mm (1/16″) to 4 mm (5/32″) depth from the outer surface of the outer concrete.
4. Paste/aggregate bond: Fair to good
5. Paste color: Similar to medium gray in the inner concrete and medium light gray in the outer concrete (Munsell® rock color N5 and N6). Similar to medium dark gray and light brown in the outer approximately 2 mm (1/16″) to 4 mm (5/32″) of the outer concrete (Munsell® rock color N4 and 5YR 5/6).
6. Paste hardness: Medium hard (Mohs' scale 3-4) in the inner concrete
7. Microcracking: Few microcracks, oriented mostly sub-parallel to the outer surface, were observed proximate to the fracture within the inner concrete. Few microcracks at various depths and orientations were observed scattered throughout the inner concrete. Few microcracks, oriented sub-perpendicular to the outer surface, proceed from the outer surface through the length of the outer concrete and intersecting the fracture within the inner concrete.
8. Secondary deposits: White, acicular ettringite was observed filling several voids and partially filling many other voids scattered throughout the sample in the outer and inner concretes. White ettringite was observed partially lining to partially filling few microcracks in the outer and inner concretes. White to similar to dark yellowish orange (Munsell® rock color 10YR 6/6) calcite was observed lining several voids in the inner concrete. White alkali silica gel was observed partially lining to lining few void spaces between approximately 94 mm (3-11/16″) to 106 mm (4-3/16″) depth from the outer surface of the inner concrete.

9. Slump: Estimated, medium (3 to 5")
10. Pozzolan/Slag presence: None observed
11. Water/cement ratio: Estimated at between 0.43 to 0.48 with approximately 1-3% unhydrated or residual portland cement clinker particles.
12. Cement hydration: Alites-fully; Belites-fully

IV. Conclusions

The general overall quality of the concrete was fair to good.

AIR VOID ANALYSIS

PROJECT:
TANK BASES
METRO SEWER PLANT, SYRACUSE NY
CRA ENGINEERING
QISI #0615-12CIV-0371, 07.006904

APS JOB NO: 10-07802

REPORTED TO:
QUALITY INSPECTION SERVICES, INC.
6730 MYERS ROAD
EAST SYRACUSE, NY 13057

ATTN: BOB MILLIMAN
DATE: JANUARY 29, 2013

Sample ID: 5 - outer concrete

Conformance:

The sample contains an air void system which is not consistent with current technology for freeze-thaw resistance.

Sample Data:

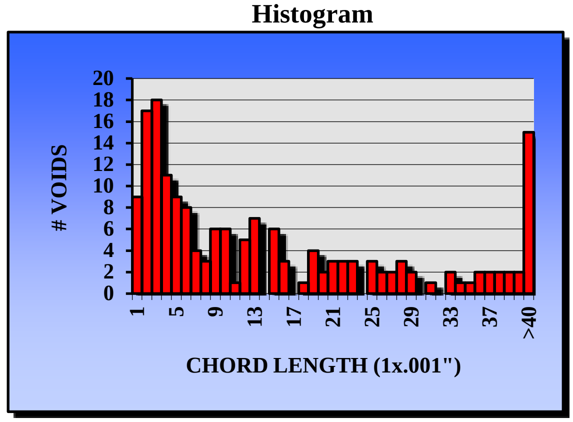
Description:	Hardened Concrete Core
Dimensions:	70 mm (2-3/4") diameter x 165 mm (6-1/2") long

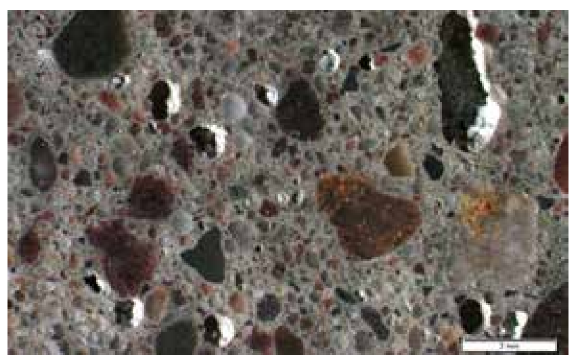
Test Data:

ASTM C457 Procedure A- Linear Traverse Method, APS SOP 00LAB003 and ACI 116R

Air Void Content, %	4.3
Entrained, %	3.2
Entrapped, %	1.1
Air Voids/inch	2.28
Specific Surface, in^2/in^3	210
Spacing Factor, inches	0.028
Paste Content, % estimated	37.2
Magnification	50x
Traverse Length, inches	75
Test Date	1/29/2013

Histogram





Magnification: 15x
Description: Overall hardened air content

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AIR VOID ANALYSIS

PROJECT:
TANK BASES
METRO SEWER PLANT, SYRACUSE NY
CRA ENGINEERING
QISI #0615-12CIV-0371, 07.006904

APS JOB NO: 10-07802

REPORTED TO:
QUALITY INSPECTION SERVICES, INC.
6730 MYERS ROAD
EAST SYRACUSE, NY 13057

ATTN: BOB MILLIMAN
DATE: JANUARY 29, 2013

Sample ID: 6 - inner concrete

Conformance:

The sample contains an air void system which is not consistent with current technology for freeze-thaw resistance.

Sample Data:

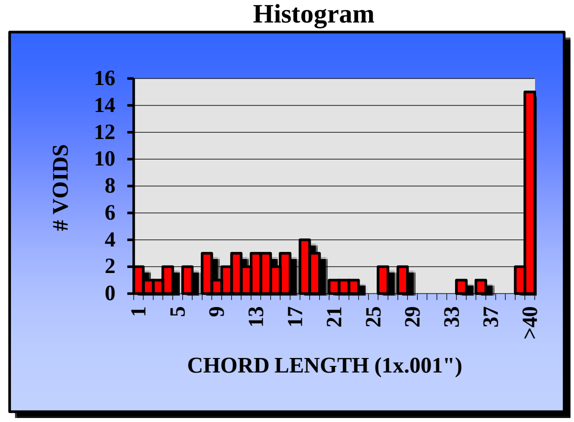
Description:	Hardened Concrete Core
Dimensions:	70 mm (2-3/4") diameter x 213 mm (8-3/8") long

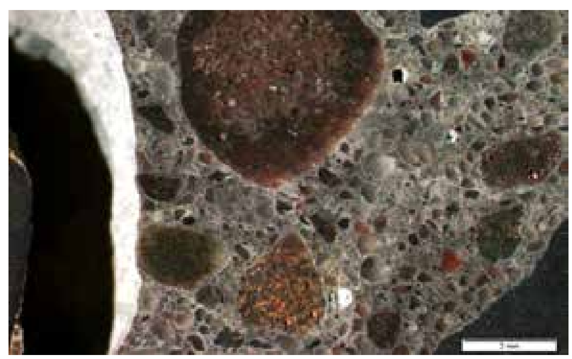
Test Data:

ASTM C457 Procedure A- Linear Traverse Method, APS SOP 00LAB003 and ACI 116R

Air Void Content, %	2.7
Entrained, %	0.9
Entrapped, %	1.8
Air Voids/inch	0.63
Specific Surface, in^2/in^3	90
Spacing Factor, inches	0.064
Paste Content, % estimated	22.0
Magnification	50x
Traverse Length, inches	100
Test Date	1/29/2013

Histogram





Magnification: 15x
Description: Overall hardened air content

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APS #: 10-07802 **DATE:** JANUARY 30, 2013
PROJECT: TANK BASES, METRO SEWER PLANT, SYRACUSE NY
CRA ENGINEERING, QISI #0615-12CIV-0371, 07.006904

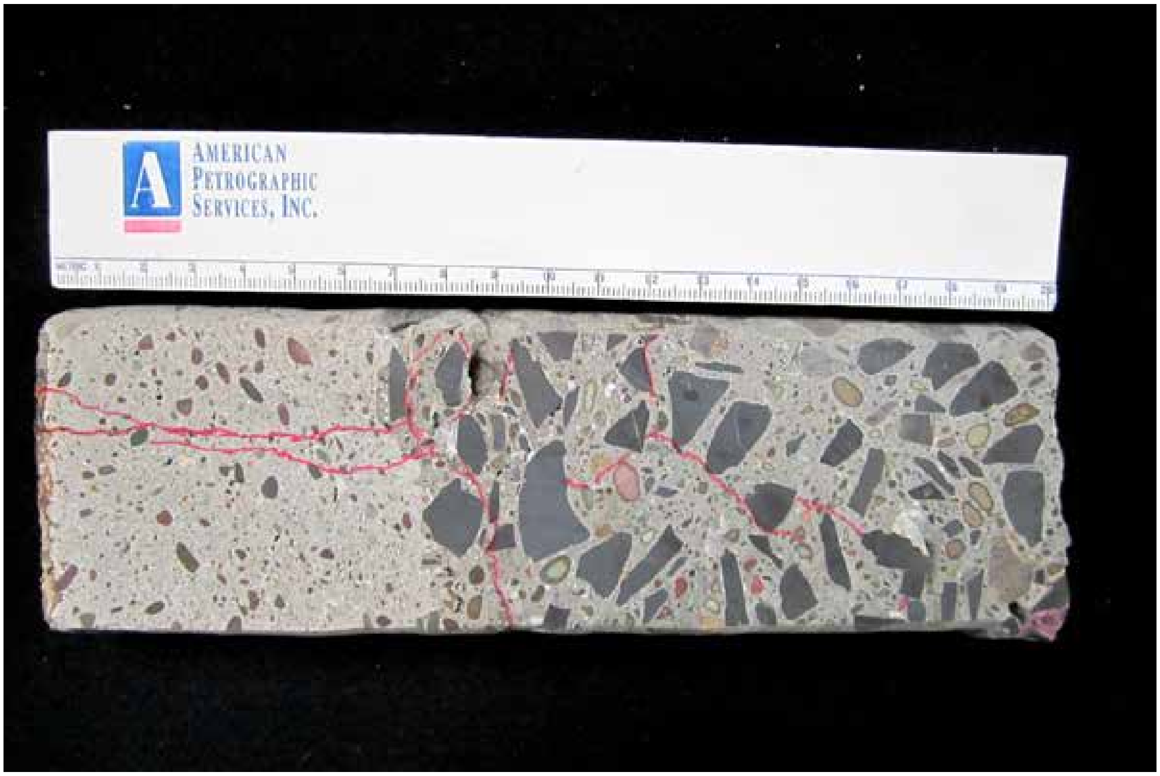
SAMPLE ID: 5 and 6 **DESCRIPTION:** Overall view of concrete core samples as received.

SAMPLE ID: 5 **DESCRIPTION:** Overall view of the outer surface of the sample.

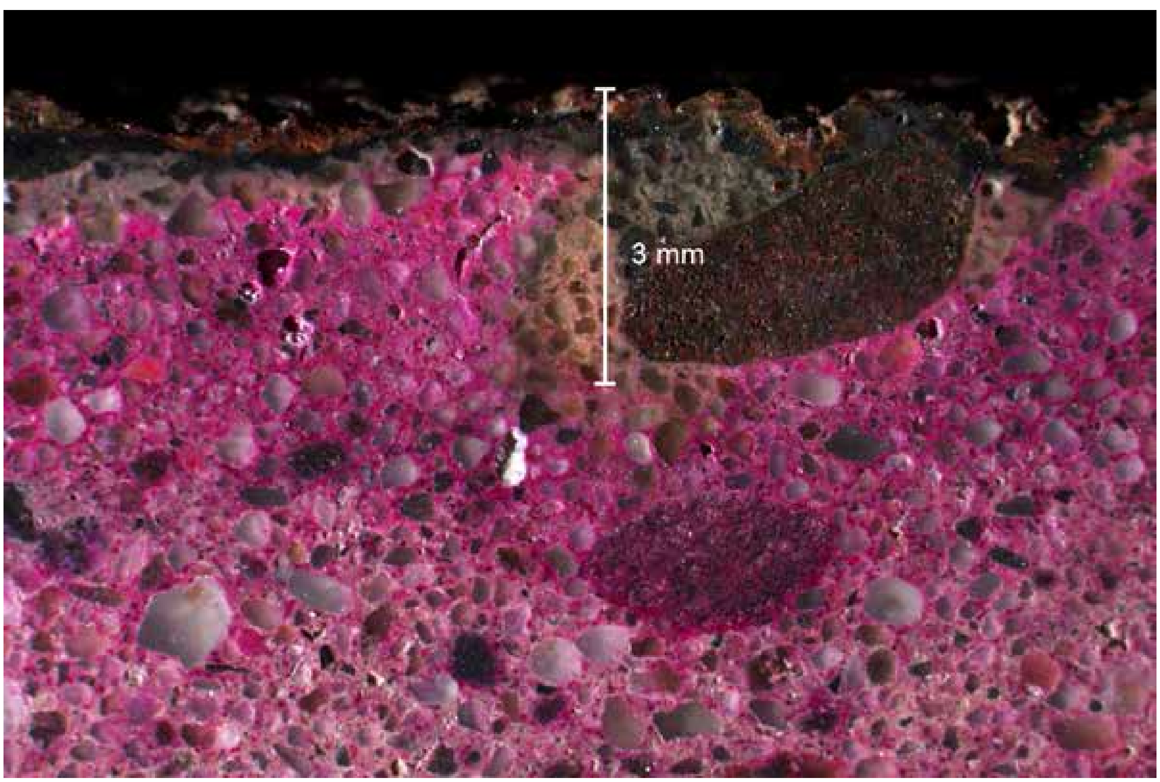
SAMPLE ID: 6 **DESCRIPTION:** Overall view of the outer surface of the sample.

SAMPLE ID: 5 **DESCRIPTION:** Overall view of a cut and polished cross section of the sample. The outer concrete is on the left side and inner concrete is on the right side of the photo. Microcracking was mapped in red ink.

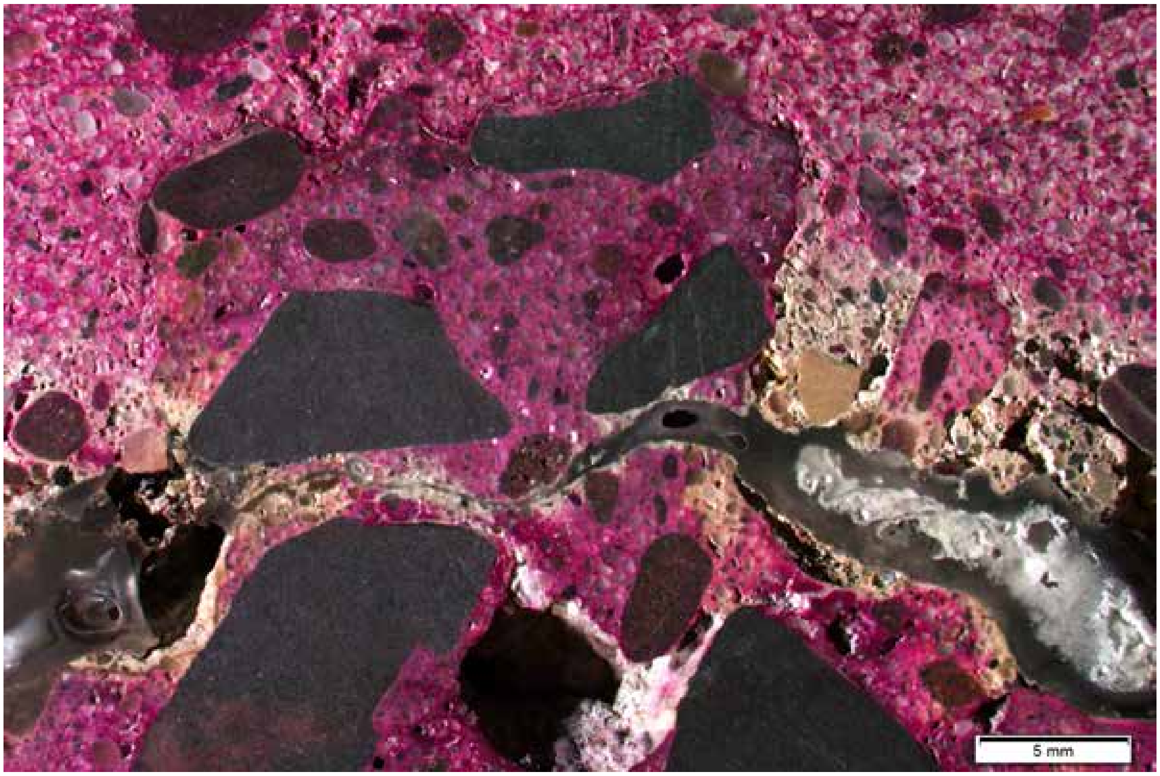
APS #: 10-07802 **DATE:** JANUARY 30, 2013
PROJECT: TANK BASES, METRO SEWER PLANT, SYRACUSE NY
CRA ENGINEERING, QISI #0615-12CIV-0371, 07.006904



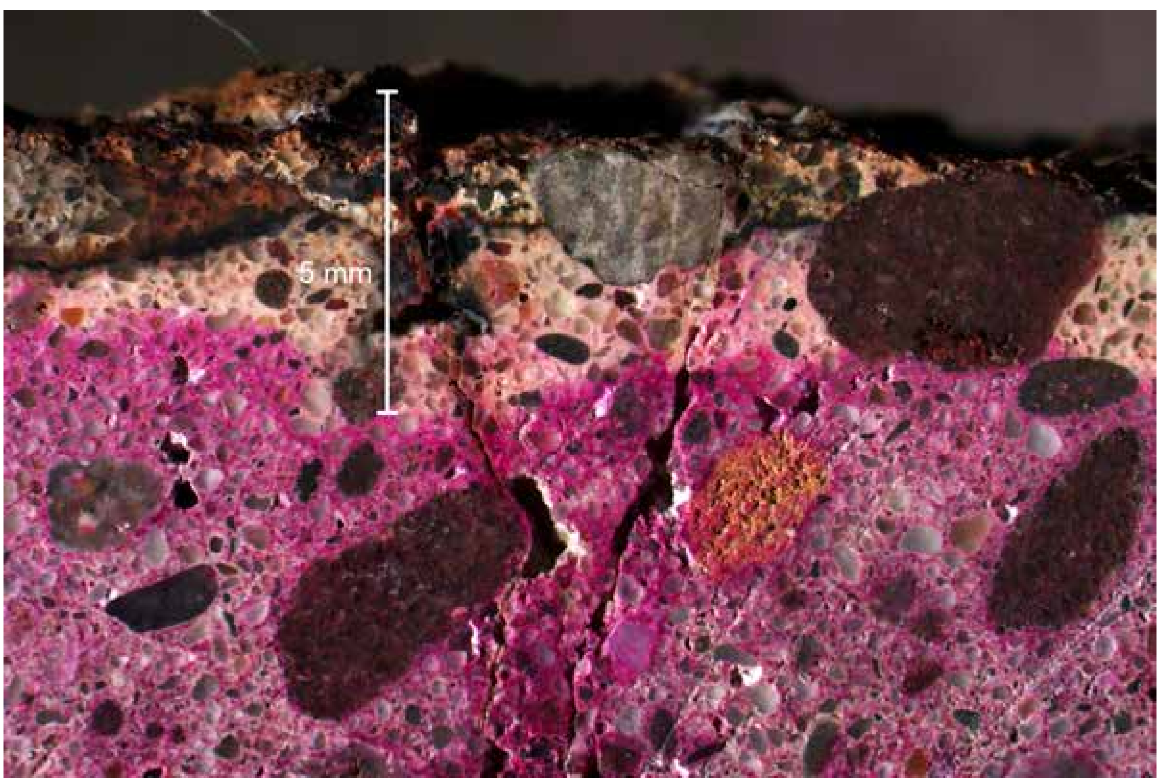
SAMPLE ID: 6 **DESCRIPTION:** Overall view of a cut and polished cross section of the sample. The outer concrete is on the left side and inner concrete is on the right side of the photo. Microcracking was mapped in red ink.



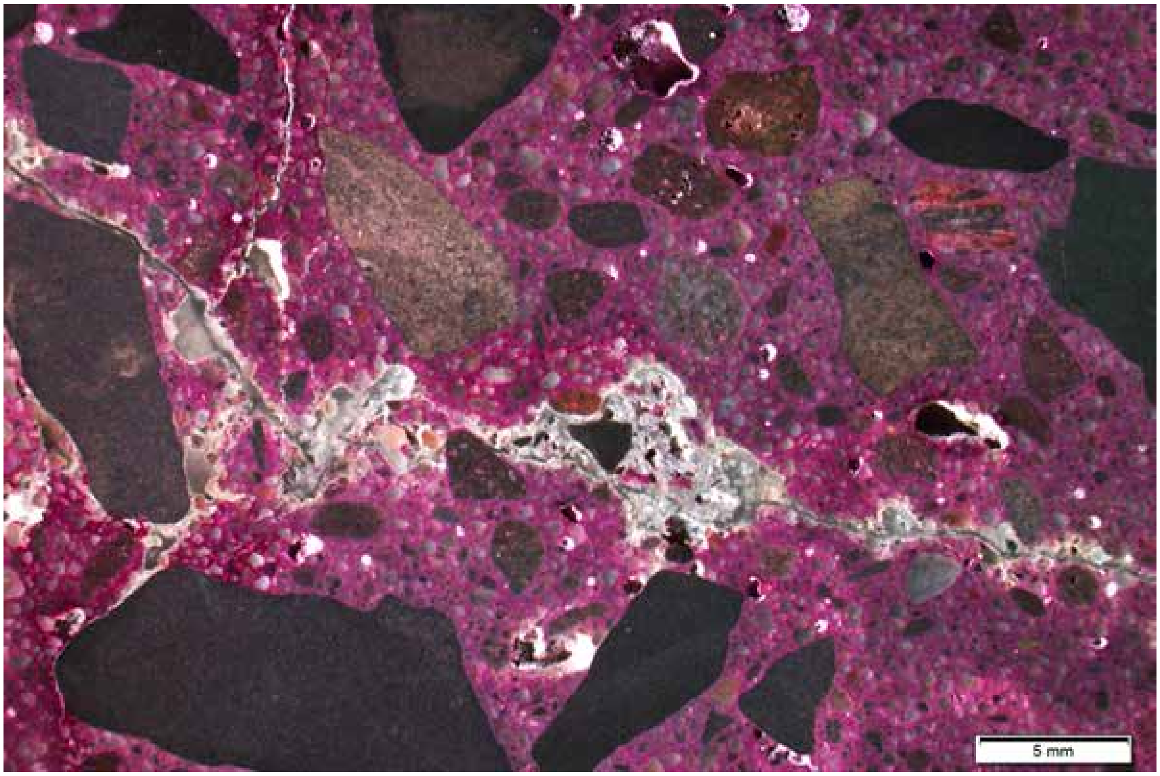
SAMPLE ID: 5 **DESCRIPTION:** Carbonation (unstained) proceeds from the outer surface of the outer concrete up to 3 mm (1/8") depth.
MAG: 15x



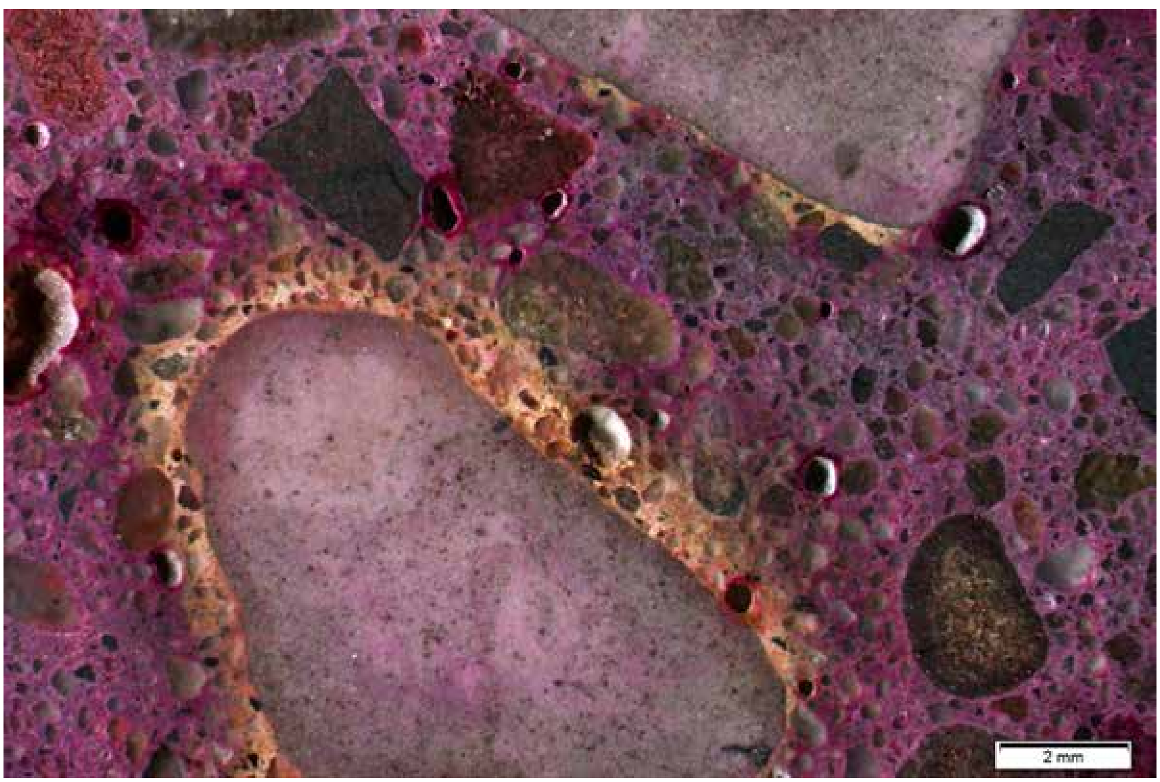
SAMPLE ID: 5 **DESCRIPTION:** Carbonation (unstained) was observed intermittently along and proximate to the fracture within the inner concrete.
MAG: 5x



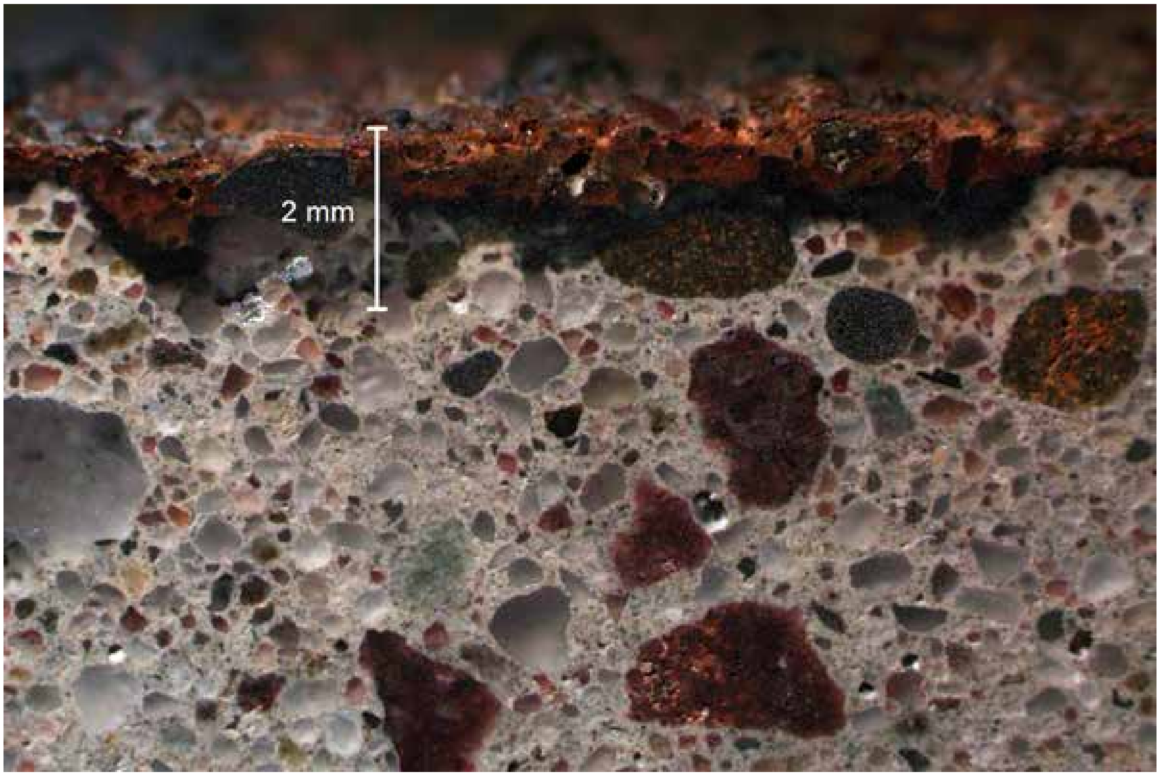
SAMPLE ID: 6 **DESCRIPTION:** Carbonation (unstained) proceeds from the outer surface of the outer concrete up to 5 mm (3/16") depth.
MAG: 10x



SAMPLE ID: 6 **DESCRIPTION:** Carbonation (unstained) was observed intermittently along and proximate to the fracture within the inner concrete.
MAG: 5x

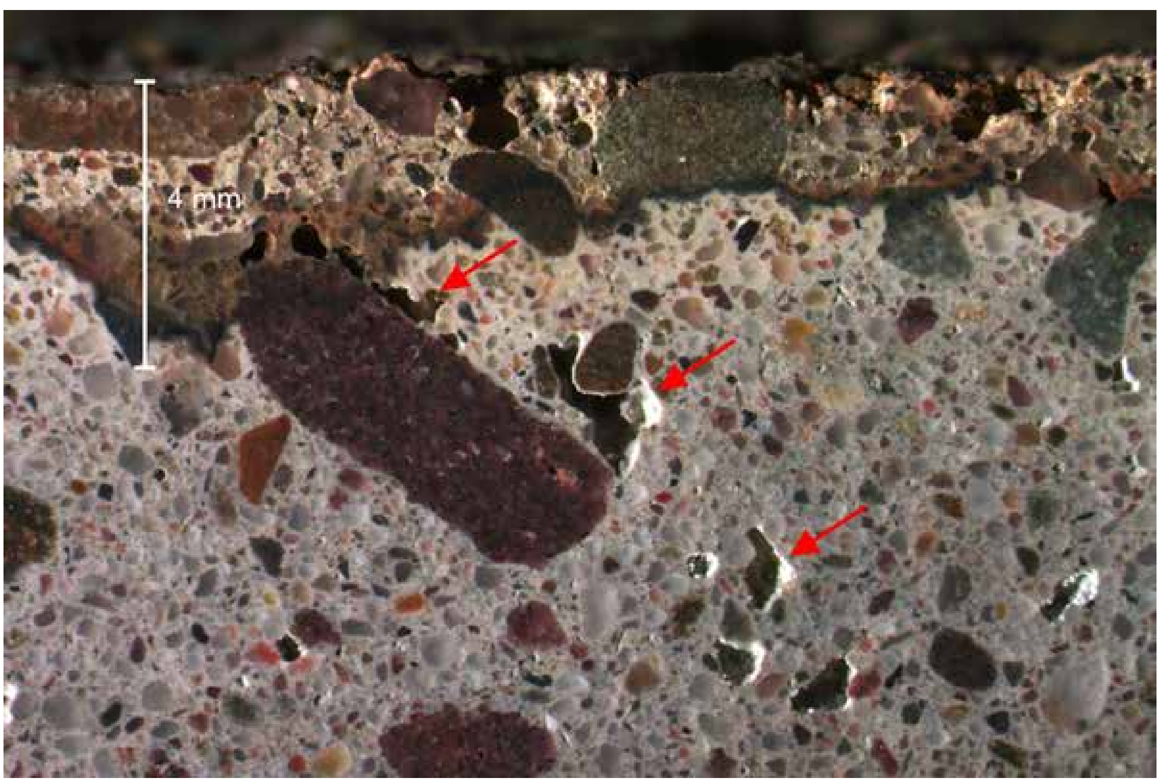


SAMPLE ID: 6 **DESCRIPTION:** Carbonation (unstained) was observed along the perimeter of few coarse aggregate particles within the inner concrete in a cut and polished cross section of concrete core.
MAG: 10x



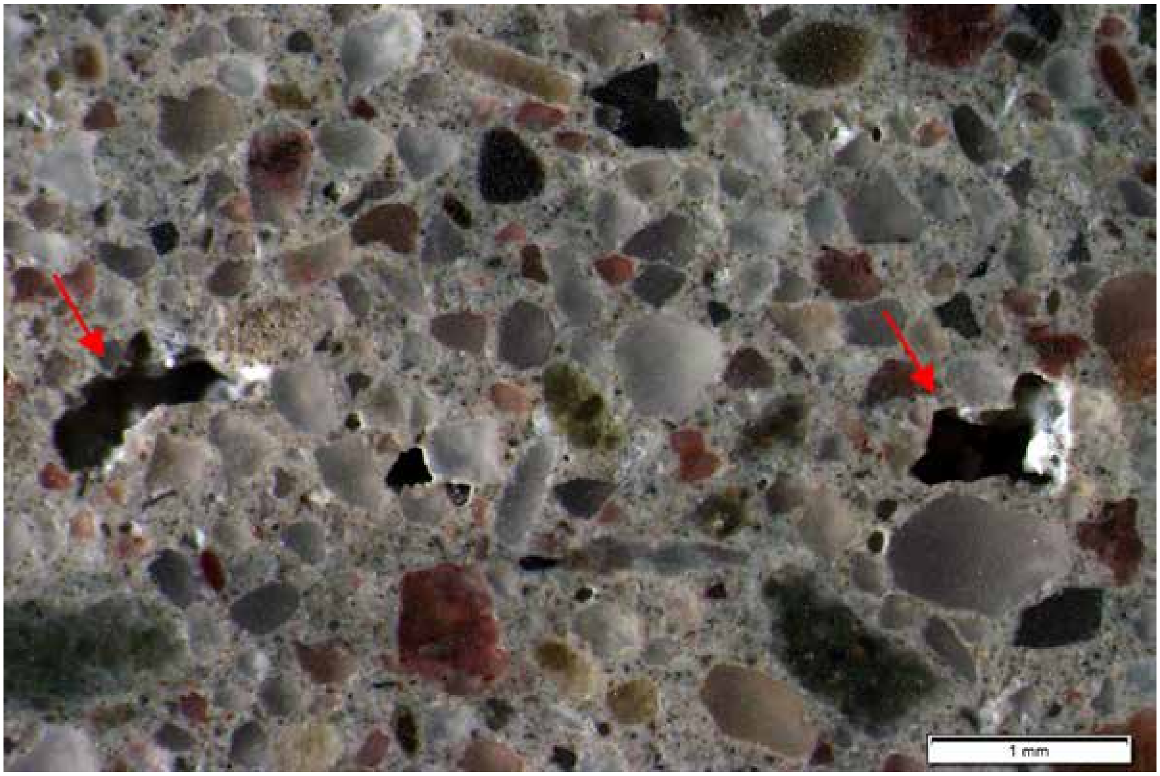
SAMPLE ID: 5
MAG: 15x

DESCRIPTION: Approximately 2 mm (1/16") of the outer surface of the outer concrete was stained medium dark gray and light brown due to a possible chemical attack in a cut and polished cross section of concrete core.



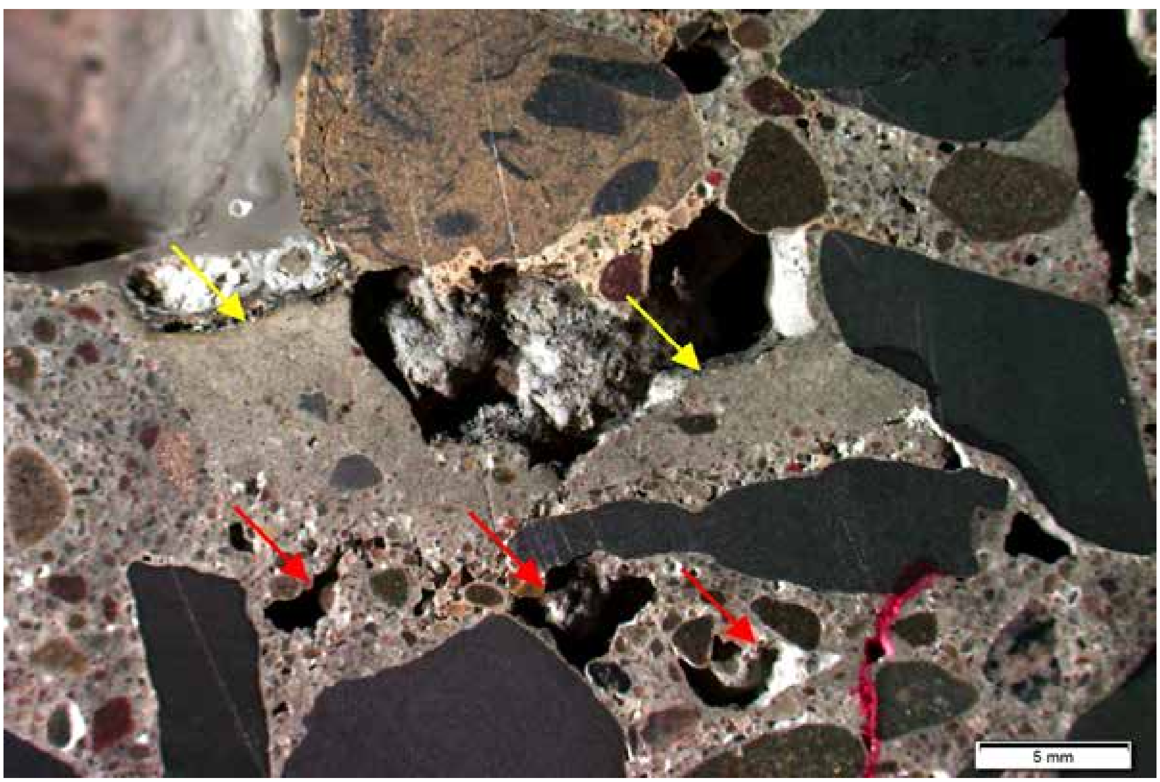
SAMPLE ID: 6
MAG: 10x

DESCRIPTION: Approximately 4 mm (5/32") of the outer surface of the outer concrete was stained medium dark gray and light brown due to a possible chemical attack. Few irregular shaped voids (red arrows) were observed in the cut and polished cross section of concrete core.



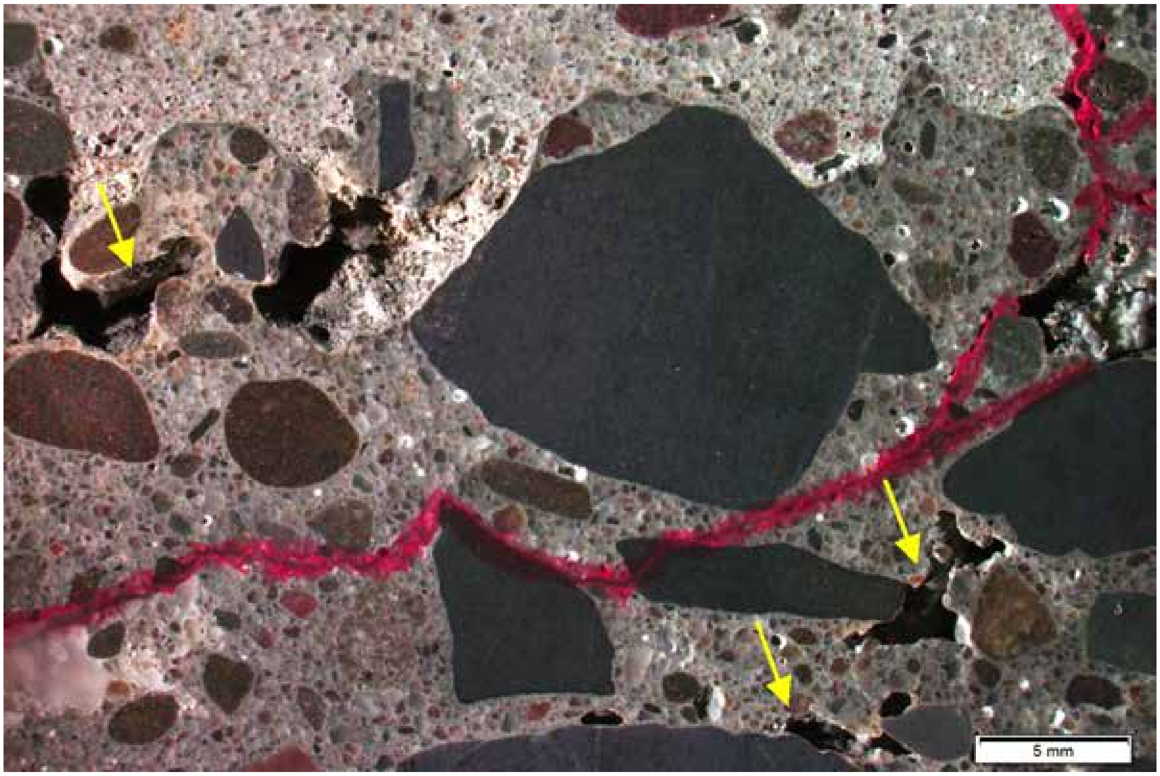
SAMPLE ID: 5
MAG: 30x

DESCRIPTION: Few irregular shaped voids (red arrows) were observed within the outer concrete in a cut and polished cross section of concrete core.



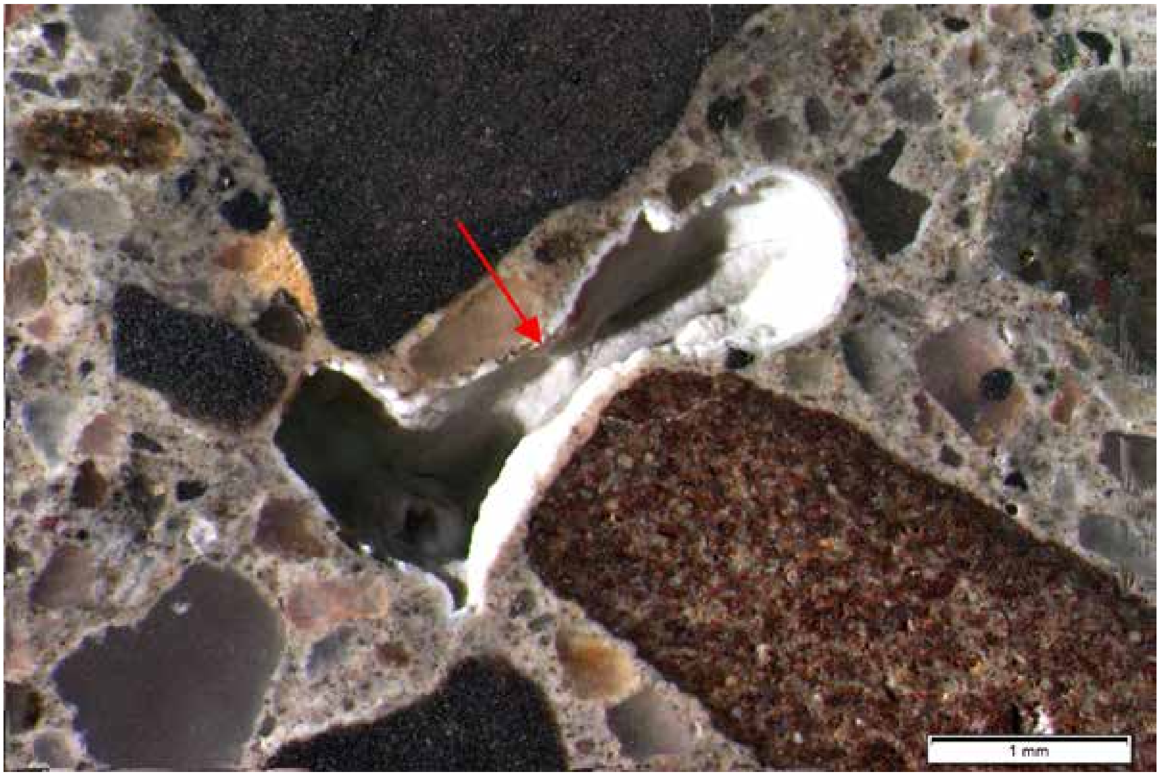
SAMPLE ID: 5
MAG: 5x

DESCRIPTION: Few irregular shaped voids (red arrows) were observed within the inner concrete in a cut and polished cross section of concrete core. Note the poorly distributed sand (yellow) in the paste.



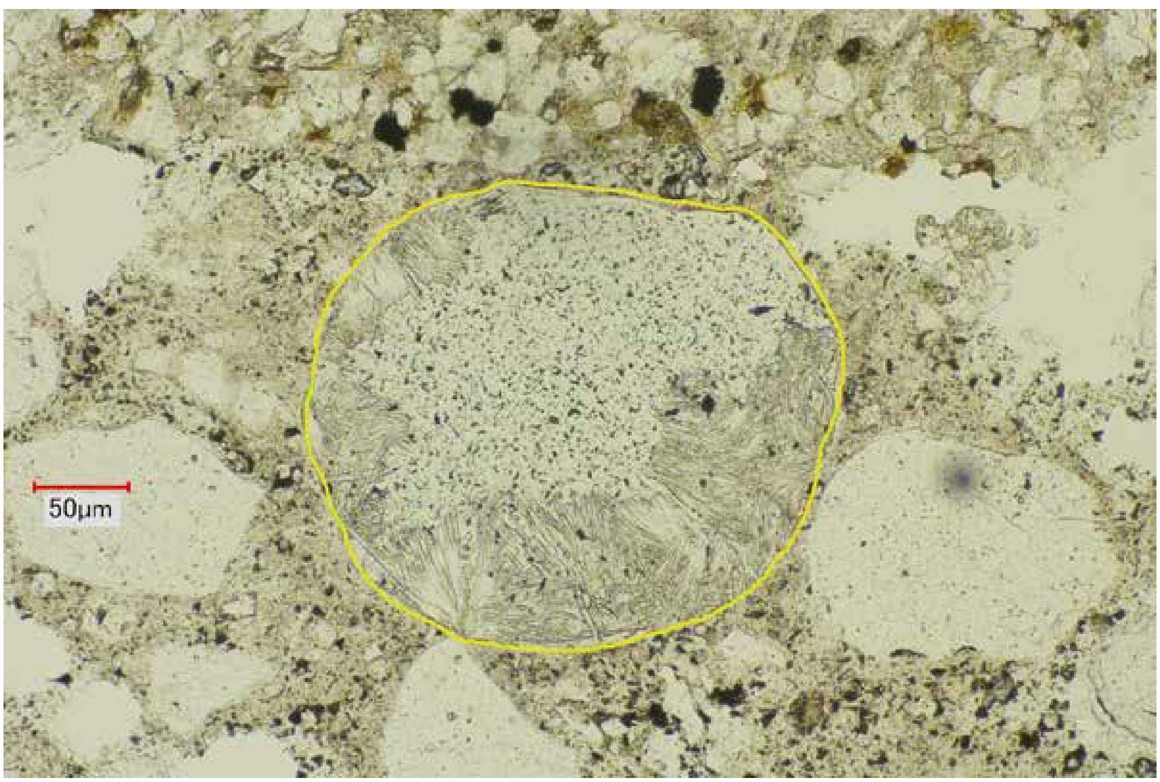
SAMPLE ID: 6 **DESCRIPTION:** Few irregular shaped voids (yellow arrows) were observed within the inner concrete in a cut and polished cross section of concrete core.
MAG: 5x

SAMPLE ID: 6 **DESCRIPTION:** White to dark yellowish orange calcite (yellow arrow) was observed lining an entrapped sized void in the inner concrete in a cut and polished cross section of concrete core.
MAG: 30x



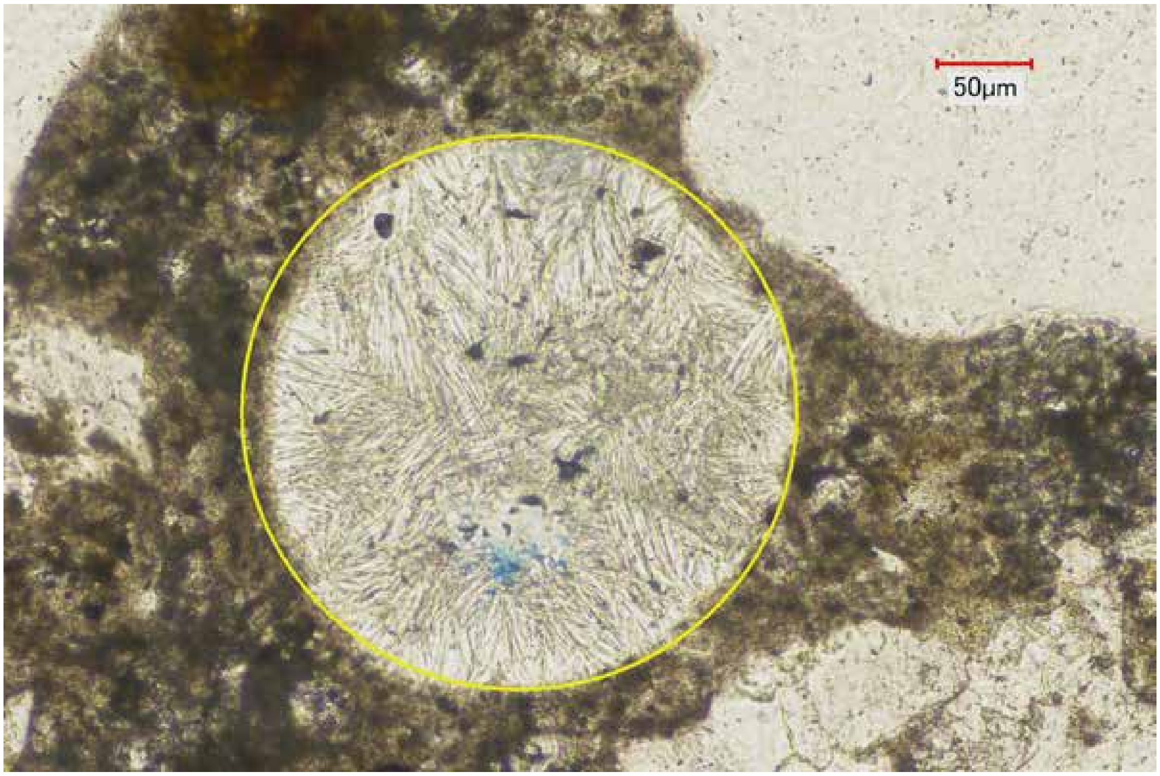
SAMPLE ID: 6
MAG: 30x

DESCRIPTION: White alkali silica gel (red arrow) was observed lining a void space in a cut and polished cross section of concrete core.



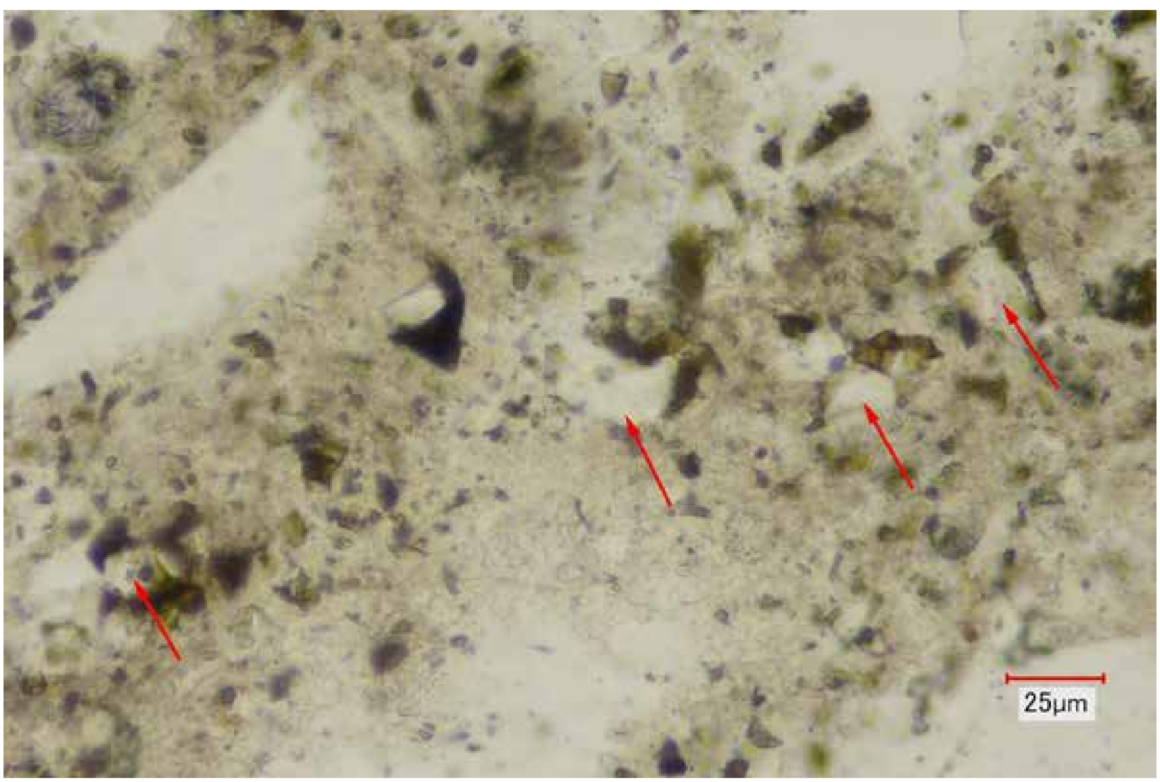
SAMPLE ID: 5
MAG: 200x

DESCRIPTION: Acicular ettringite partially filling an air void (yellow outline) in thin section of concrete under plane polarized light.



SAMPLE ID: 6
MAG: 200x

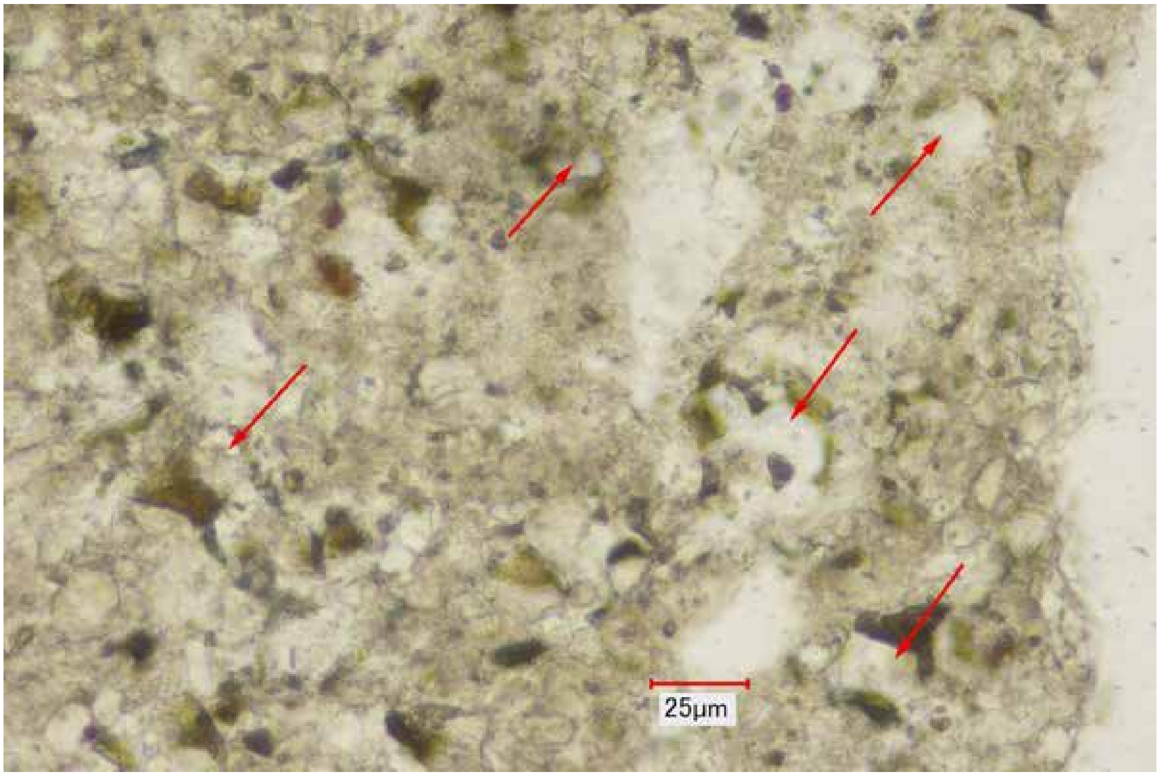
DESCRIPTION: Acicular ettringite filling an air void (yellow circle) in thin section of concrete under plane polarized light.



SAMPLE ID: 5
MAG: 400x

DESCRIPTION: Fully hydrated portland cement clinker particles (red arrows) in thin section of concrete under plane polarized light.

APS #: 10-07802 **DATE:** JANUARY 30, 2013
PROJECT: TANK BASES, METRO SEWER PLANT, SYRACUSE NY
CRA ENGINEERING, QISI #0615-12CIV-0371, 07.006904



SAMPLE ID: 6 **DESCRIPTION:** Fully hydrated portland cement clinker particles (red arrows) in thin section of concrete under plane polarized light.
MAG: 400x

Quality Inspection Services, Inc.
Syracuse Office
6730 Myers Road • East Syracuse, New York 13057
(315) 431-4291 • Fax (315) 431-4292
Visit Us At: www.qisi.com or www.applusrtd.com

Applus RTD

Compressive Strength Test Report

Project: Metro Sewage Treatment Plant Tank Coring

Client: CRA Engineers (Casey Cowan)

Contractor: OpTech (Core supplier)

:

Cylinder Compression Machine Q #: 0605 Cal. due date: 1-25-2013

Mix Data: UnKnown Concrete has been in place for 25+ years Set No: NA

Date Molded: Un Known Date Received: 12-20-12

Condition Received: Received from OpTech sealed in bags

Sample Location: Bottom of settlement tanks

Cubic Yards Placed: NA

Specimens Cast By: Cores were drilled by OpTech per the client

Time Specimens Made: NA Truck No.: NA

Material Temperature (C-1064): °F NA Air Temperature: °F NA

Slump (C-143): NA

Remarks: **Samples cored from old tank base slab by OpTech**

Strength Specification @ 28 days: NA

COMPRESSIVE STRENGTH DATA

Laboratory #	*Date Tested*	*Age (Days)*	*Diameter*	*Length*	*Cross Sectional Area (in^2)*	*Maximum Load (lbs)*	*Compressive Strength (PSI)*
1	12-21-12	NA	2.72	6.00	6.28	32390	5160
3	12-21-12	NA	2.73	6.00	6.28	33850	5390
4	12-21-12	NA	2.75	6.00	6.34	29730	4690

Please Note; Additional samples have been sent out for petro graphic analysis

Respectfully Submitted, Quality Inspection Services, Inc.