City of Manteca Wastewater Quality Control Facility Influent Pump Station Condition Assessment

Prepared for: Phil Govea, P.E., City of Manteca

Prepared by: Noy Phannavong, V&A

Reviewed by: Mike Oriol, P.E., V&A
Glenn Willson, P.E., V&A

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INTRODUCTION

V&A was retained by the City of Manteca (City) to perform a condition assessment at the Influent Pump Station (IPS) for the City's Wastewater Quality Control Facility (WQCF). The intent of the assessment was to determine the mechanism and severity of ongoing deterioration in the Influent Room of the IPS and develop associated concrete repair and coatings recommendations. ICM Group (ICM), a construction management (CM) firm that provides the City with CM services, provided general assistance to V&A during the condition assessment. ICM also evaluated the feasibility of performing subsequent rehabilitation work that would stem from the assessment. A preliminary reconnaissance visit to the site was made on April 27, 2012, and the Influent Room condition assessment was conducted on May 9 and 11, 2012. The preliminary visit allowed V&A to develop its condition assessment approach and allowed ICM to make the Influent Room accessible from the wet well side of the building.

The condition assessment consisted of visual observations with photographic documentation of the interior surfaces of the structure and associated components. Quantitative measurements were also made, including concrete penetration tests, concrete pH tests, and measurement of concrete cover depth over the reinforcing steel. Three core samples from two representative locations were taken by Christensen Materials Engineering (CME) to determine existing concrete thickness, concrete strength, and depth of cement mortar degradation.

INFLUENT PUMP STATION DESCRIPTION

The IPS, which entered service in 2004 or 2005, is responsible for screening and pumping of all wastewater flow entering the WQCF. According to the City's data for the month of April 2012, the typical daily flows vary from 1.5 to 10 million gallons per day (mgd). Flows enter the IPS and combine in the Influent Room from two 60-inch-diameter trunk sewers, one from the west (North Trunk Sewer) and one from the south (South Trunk Sewer). Leaving the Influent Room, the combined flow passes through bar screens and into the IPS wet well.

The Influent Room is separated from the bar screens and wet well by a concrete wall that extends across the top of the flow channels. The flow channel headspace allows a small part of the atmosphere inside the Influent Room to escape into the wet well side. The Influent Room appears to mostly contain its atmosphere, including any gases entering from the sewers or released from the wastewater within the room. Both the Influent Room and wet well side are equipped with ventilating ducts.

The concrete walls of the Influent Room including the baffle wall, bar screen channels and wet wells are lined with a T-lock PVC lining system from each wall's base elevation up to Elevation -0.36 feet (approximately 2 feet below the top of the grating at Elevation 1.36 feet). Concrete surfaces above Elevation -0.36 feet are not lined.

Figure 1 and Figure 2 show a partial plan and section of the IPS. Core sample locations are also shown on the figures.

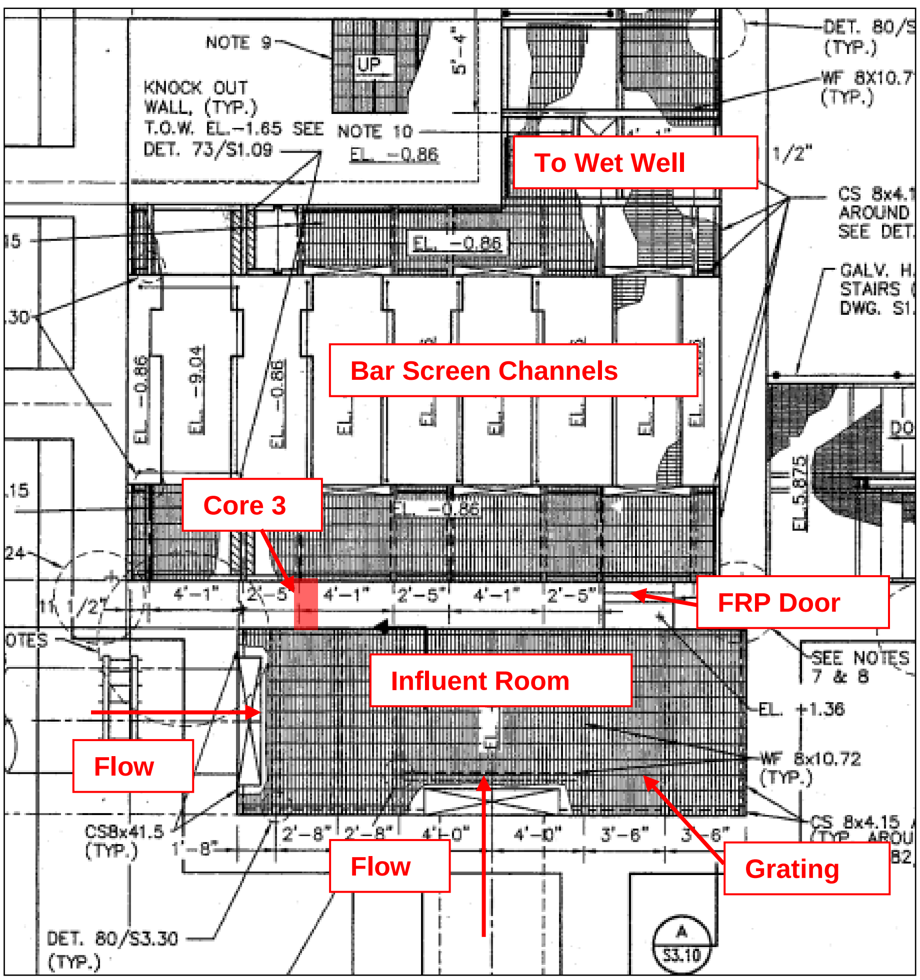


Figure 1. Partial Plan of IPS Showing Influent Room, Bar Screen Channel and Wet Well

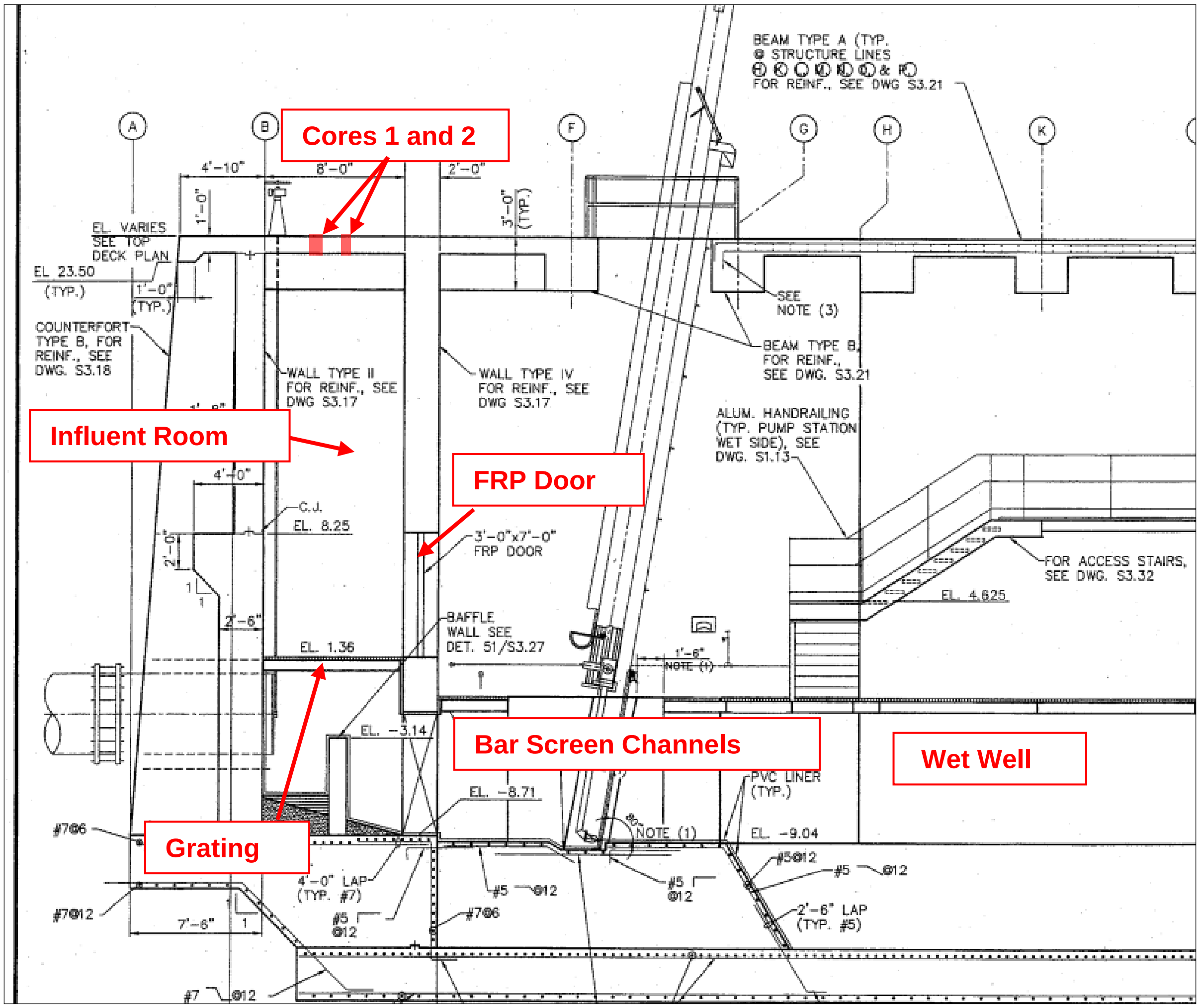


Figure 2. Partial Section of IPS Showing Influent Room, Bar Screen Channel and Wet Well

METHODS AND PROCEDURES

Access and Confined Space Entry

The interior of the IPS is considered a permit-required confined space. A confined space permit was completed and signed by members of the entry team. Entrants wore personal four-gas monitors, and the attendant recorded atmospheric gas readings on the entry permit using an additional four-gas monitor.

The Influent Room roof access hatches were opened and blowers were used to provide ventilation of the work areas. Turbulence in the wastewater in the Influent Room releases high levels of hydrogen sulfide (H_2S) gas, which could not be controlled with the available ventilation equipment. As a result, entry into the room was only conducted during the early morning hours of May 11 with the influent lines closed off.

One entrant was allowed to enter the Influent Room at a time. While inside the Influent Room, the entrant was secured to a self-retracting lifeline lowered from a tripod situated over one of the roof access hatches. A winch was used for lowering the entrant into the flow channels and kept available for emergency retrieval from the Influent Room if necessary.

Access to the Influent Room was primarily through a fiberglass-reinforced plastic (FRP) door from the wet well side of the IPS. This door was found seized shut, so ICM cut out the center of the door panel during the preliminary visit on April 27. During the assessment on May 11, ICM also cut out a portion of the grating inside the Influent Room to allow access to the flow channels below.

Visual Evaluation

The primary investigative method consisted of conducting visual examinations and documenting observations with digital photographs. The visual assessment focused on the condition of the lining system and corrosion of concrete surfaces and reinforcing steel. Structural defects such as large cracks, spalls, and corrosion of reinforcing steel and fasteners were noted when found. It should be noted that much of the condition assessment data is subjective and based on the evaluator’s expertise.

Concrete Evaluation Techniques

Penetration Tests

Penetration tests involve applying a consistent level of force from a chipping hammer to the concrete surface, until sound material is reached, and then measuring the depth of the resulting cavity. The cavity depth provides an estimate of the integrity and condition of the concrete surfaces. Typically, as concrete deteriorates, the cement paste begins to lose integrity and becomes soft. The sound produced by the hammer strike also provides qualitative information on the presence of voids below the surface.

pH Measurement

One indicator of the corrosivity of an environment is the pH of the existing concrete surface. The surface pH was tested in place using Hydrion Insta-Chek paper strips and also from samples of the concrete that were collected during the assessment. The samples were tested using an electronic pH probe that was calibrated using pH 4.0 and 10.0 buffer solutions.

V&A has developed a table correlating the effect of the pH of the surface concrete on the concrete corrosion rate, as shown in Table 1. The data in Table 1 is derived from past experience and review of literature such as ACI *Technical Document C-24, Durable Concrete*.

Table 1.
pH-Corrosion Correlation Table for Concrete

Concrete pH	Degree of Corrosivity
< 2	Severe
2 to 4	Heavy
4 to 5	Moderate
5 to 6	Light
> 6	Negligible

Pressure Washing

Pressure washing was performed to remove debris and loose or deteriorated concrete from the concrete surfaces. Each pressure-washed area was inspected and the amount of deteriorated concrete removed or exposed reinforcing steel, if any, was noted. The pressure washer used develops 2,000 pounds per square inch (psi) of water pressure.

Sounding

Sounding a surface refers to tapping the concrete surface with a chipping hammer and listening for discontinuities beneath the surface. Locations for sounding tests were selected at the discretion of the evaluator.

VANDA™ Concrete Condition Index Rating System

The VANDA™ Concrete Condition Index was created by V&A to provide consistent reporting of corrosion damage based on qualitative, objective criteria. As shown in Table 2, the condition of concrete corrosion can vary from Level 1 to Level 4 based upon visual observations and field measurements, with Level 1 indicating the best case and Level 4 indicating severe damage.

Table 2.
VANDA™ Concrete Condition Index Rating System

Condition Rating	Description	Representative Photograph
Level 1	**None/Minimal Damage to Concrete** Hardness: No Loss Surface Profile: No Loss Cracking: Shrinkage Cracks Spalling: None Reinforcing Steel : Not Exposed or Damaged	
Level 2	**Damage to Concrete Mortar** Hardness: Damage to Concrete Mortar Surface Profile: Some Loss Cracking: Thumbnail Sized Cracks of Minimal Frequency Spalling: Shallow Spalling of Minimal Frequency, Related Reinforcing Steel Damage Reinforcing Steel : May Be Exposed but Not Damaged	
Level 3	**Loss of Concrete Mortar/Damage to Reinforcing Steel** Hardness: Complete Loss Surface Profile: Large Diameter Exposed Aggregate Cracking: ¼-inch to ½-inch Cracks, Moderate Frequency Spalling: Deep Spalling of Moderate Frequency, Related Reinforcing Steel Damage Reinforcing Steel: Exposed and Damaged, Can Be Rehabilitated	
Level 4	**Reinforcing Steel Severely Corroded/Significant Damage to Structure** Hardness: Complete Loss Surface Profile: Large Diameter Exposed Aggregate Cracking: ½-inch Cracks or Greater, High Frequency Spalling: Deep Spalling at High Frequency, Related Reinforcing Steel Damage Reinforcing Steel: Damaged or Consumed, Loss of Structural Integrity	

INFLUENT ROOM ASSESSMENT FINDINGS

Unprotected Concrete

The unprotected interior concrete surfaces of the Influent Room are severely deteriorated due to biogenic corrosion. These surfaces include the roof and the four walls (north, east, south, and west walls) from the roof at Elevation 24 feet down to Elevation -0.36 feet. Dissolved sulfide contained in the incoming wastewater is released as H_2S gas into the headspace of the Influent Room by turbulence and splashing caused by the convergence of the North and South Trunk Sewers. The H_2S gas molecules are then metabolized and converted into sulfuric acid (H_2SO_4) by species of bacteria called *Acidithiobacillus.* These species of bacteria are known to colonize surfaces within sewer headspaces where an abundance of H_2S gas is present. The sulfuric acid that the bacteria produce is detrimental to concrete surfaces.

The concrete in the Influent Room was tested in place for pH using Hydrion Insta-Chek paper strips. In addition, concrete samples were collected for in-house testing using an electronic pH probe. The results of the pH testing are summarized in Table 3.

Table 3.
pH Testing Results

Location	Concrete pH Test Strip / Sample	Degree of Corrosivity
Deck slab near west gate opening	2 / 3.3	Heavy
East wall at approx. Elevation 5.36 feet	1 / 1.5	Severe
South wall at approx. Elevation 5.36 feet	1 / 1.6	Severe

The test strips can sometimes be difficult to use in the field when the concrete surface is dry. The concrete samples were obtained and tested to confirm the results from the test strips. However, the pH from the concrete samples will sometimes be more alkaline (higher) than the pH from the test strip if alkaline concrete beneath the outermost surface is also collected. In this case, however, both test procedures confirm that the uncoated interior concrete surfaces of the Influent Room are undergoing heavy to severe corrosion.

As a result of the severe biogenic corrosion, large amounts of soft cement paste (calcium sulfate) and aggregate have delaminated off of the walls and ceiling and are piling up around the perimeter of the grating. Penetration measurements revealed that the extent of concrete degradation on the interior walls and roof of the Influent Room ranges from 0.75 to 1.75 inches into the original concrete surface. With this much degradation, reinforcing steel can become exposed and subject to biogenic corrosion. Pressure washing was performed in a few areas to remove loose and deteriorated concrete and to determine if reinforcing steel would be exposed. No reinforcing steel was exposed as a result of the pressure washing. However, a stray piece of reinforcing steel was exposed on the south wall approximately 7 feet above the grating. It was a horizontal bar extending from the west wall and was approximately 4 feet long. The exposed reinforcing steel showed moderate to heavy corrosion.

For corrosion protection of reinforcing steel, the minimum depth of concrete cover over reinforcing steel is 2 inches (3 inches on the face of concrete exposed to soil). Depths to reinforcing steel in the Influent Room were measured on the east, south and north walls. The results are summarized in Table 4.

Table 4.
Depth to Reinforcing Steel Measurement Summary

Location	Depth of Concrete Cover Horizontal Bar (inches)	Depth of Concrete Cover Vertical Bar (inches)
East wall	> 3.5	> 3.5
South wall, near east wall	2.5	2.9
South wall, near west wall	1.2	1.9
North wall	1.9	1.7

During the preliminary visit, ICM determined that the concrete around the penetration of the south inlet was deteriorated and that up to 6 inches of concrete beneath the invert may have corroded away. V&A could not investigate this further since the invert of the inlet was blocked by the closed sluice gate.

Photo 1 through Photo 8 show the observations from the unprotected concrete assessment.

Photo 1. View of Influent Room looking at west wall showing pile of deteriorated concrete around perimeter of grating.

Photo 2. View of Influent Room looking at south wall showing pile of deteriorated concrete around perimeter of grating.

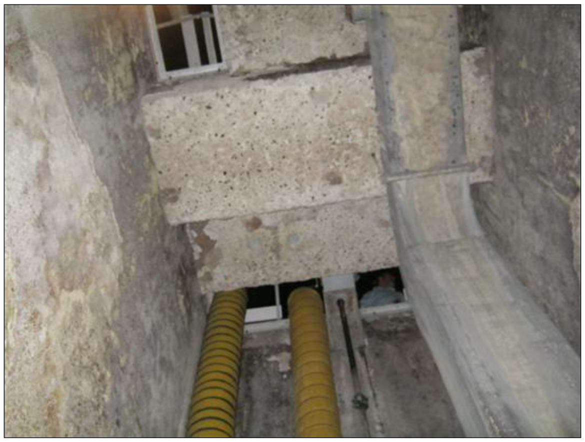


Photo 3. View of Influent Room looking at roof showing deteriorated concrete on walls and roof.

Photo 4. Pressure-washed area showing medium and large diameter aggregate, but no reinforcing steel.

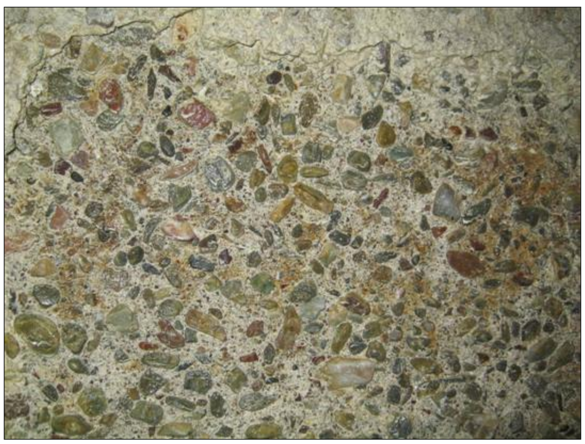


Photo 5. Detail of pressure-washed area showing medium and large diameter aggregate, but no reinforcing steel.

Photo 6. Side profile of concrete wall deterioration showing approximately 1.75 inches of concrete lost.

Photo 7. Exposed stray reinforcing steel on south wall.

Photo 8. Detail of exposed stray reinforcing steel on south wall.

PVC T-Lock Lined Concrete and Floor

The upper edge termination of the PVC T-Lock liner in the Influent Room is peeled back and delaminated from the concrete substrate. Some termination edges were delaminated worse than others with the worst locations having about 4 inches of lining peeled back from the corroded concrete wall. Away from the upper termination edges, the T-Lock on the walls of the flow channel is in good condition. Tapping at several surfaces of the T-Lock away from the termination edges did not reveal that the liner has delaminated from the concrete substrate elsewhere. PVC weld strips at the T-Lock joints appear to have good adherence and to be in good condition.

The floor of the flow channel is not lined. However, since the floor is usually submerged, biogenic corrosion does not occur on its surface. Erosion corrosion appears to have caused some deterioration just beneath the south gate, where small diameter aggregate are exposed. Overall, the floor of the flow channel is in good condition.

Photo 9 through Photo 16 show the observations on the PVC T-Lock liner in the Influent Room.

Photo 9. PVC T-lock liner termination below grating.

Photo 10. PVC T-Lock liner delaminating away from deteriorated concrete.

Photo 11. T-lock liner away from termination edge in good condition.

Photo 12. T-Lock liner on baffle wall in good condition.

Photo 13. PVC T-Lock on walls of flow channel in good condition.

Photo 14. Minor erosion corrosion on floor of flow channel.

Photo 15. Concrete deterioration around south inlet penetration and T-Lock liner peeling on inlet pipe.

Photo 16. Concrete deterioration around west inlet penetration.

Core Sampling Results

Three concrete core samples were obtained by CME from the roof slab and north wall of the Influent Room to be tested for compressive strength and analyzed for depth of surface deterioration by macro-section analysis. Cores 1 and 2 were obtained from the roof slab with Core 1 (3.71-inch diameter) being larger than Core 2 (2.71 inches). Core 3 was obtained from the north wall and was 3.71 inches in diameter. Cores 1 and 3 were tested for compressive strength per ASTM C42. Cores 2 and 3 were split in half along their lengths and stained with phenolphthalein indicator solution, which turns pink at pH greater than 10 and is colorless at pH less than 10. This shows the extent of degradation that has occurred from the surface. Conclusions from the CME Concrete Testing Report, which is provided in Appendix A, are summarized as follows:

- There is 13 inches (nominal thickness is 12 inches) of sound concrete in the Influent Room roof slab at the location of Core 2. Due to time constraints for drilling Core 3 on the north wall, the core machine was unable to penetrate through the wall and was stopped at a depth of approximately 20.25 inches into the wall. There is greater than 20.25 inches of sound concrete in the Influent Room wall at the location of Core 3. V&A estimates that there is between 22.5 to 23.5 inches (nominal thickness is 24 inches) of sound concrete in the north wall.
- The concrete samples had a strength of 5,910 psi for the roof slab and 4,880 psi for the north wall.

Miscellaneous

The aluminum grating in the Influent Room was moderately to severely corroded in places. Corrosion pitting and exfoliation have caused holes and perforations to develop in the thin members of the grating. The grating corrosion is scattered, and the grating system as a whole is in fair condition. However, there is a patch of grating beneath the HVAC ducting that has corroded through. Thicker members of the grating system, such as the aluminum support beams and stainless steel anchor bolts, have experienced only minor corrosion and have retained their structural integrity. Photo 17 through Photo 20 show the observations on the grating system.

Photo 17. Aluminum grating in fair condition in most places.

Photo 18. Small holes and perforations in thin members of grating.

Photo 19. Patch of grating beneath HVAC ducting corroded through.

Photo 20. Aluminum beams and rafters covered with aluminum oxide but still sound.

The sluice gates showed minor surface corrosion in places, but operated and sealed without issues during the assessment. When fully closed, the south gate leaked approximately 2 to 5 gallons per minute (gpm) of water. The west gate was fully sealed and did not leak any water. During the preliminary visit, ICM determined that some concrete damage may be present behind the gate mounting plates. V&A investigated this by sounding on the steel mounting plate. The sound returned was between a “ping” sound (expected when the concrete behind is solid) and a hollow sound (expected when a void exists behind the steel bracket). This indicates that the concrete behind is deteriorated but not to the extent that significant voids exist behind the steel plate. Photo 21 through Photo 24 show the observations on the sluice gates.

Photo 21. Surface corrosion and pitting on south sluice gate mounting/guide plate.

Photo 22. Surface corrosion and pitting on south sluice gate.

Photo 23. South sluice gate leaking approximately 2 to 5 gpm.

Photo 24. West sluice gate with corrosion similar to south sluice gate.

The HVAC ducting in the Influent Room was missing its screen but appears to be functioning. Photo 25 and Photo 26 show the observations on the HVAC ducting.

Photo 25. Screen to HVAC ducting missing.

Photo 26. HVAC ducting appears to be open.

CONCLUSIONS

In the relatively short service life of the IPS, ongoing biogenic corrosion has caused severe concrete deterioration to the unprotected concrete within the Influent Room head space. Though there was significant concrete degradation, minimal reinforcing steel was exposed. Concrete core sampling determined that good concrete thickness remained and that the concrete had good strength. Overall, the unprotected concrete surfaces within the Influent Room are in a VANDA Level 3 concrete condition. The PVC-lined concrete surfaces below the grating are in good condition, but have begun to delaminate at the termination edge due to concrete corrosion at the termination edge. The aluminum grating is moderately to severely corroded and should not be used as a working platform without additional support. The grating support beams and anchor bolts are in fair condition. The sluice gates showed minor surface corrosion but operated and sealed without issues during the assessment.

RECOMMENDATIONS

Concrete Repair and Coatings Recommendations

Based on the Influent Room condition assessment findings, V&A presents the City with two options to repair the corroded concrete surfaces and protect the structure from further corrosion damage.

- **Option 1: Arrow-Lock PVC Lining System** – Arrow-Lock PVC liners function the same way as PVC T-Lock liners. However, Arrow-Lock is primarily used as a rehabilitation product and not for new construction. Unlike T-Lock, Arrow-Lock can be applied on vertical or horizontal concrete surfaces that have already been cured. The installation requires a four-step process after the concrete has been cleaned, abraded and resurfaced:

  1) Spray application of a waterborne epoxy primer.
  2) Trowel application of an epoxy mastic.
  3) Embedment of the Arrow-Lock sheet into the epoxy mastic before it is cured.
  4) Welding of joint strips over seams.

- **Option 2: Epoxy Novolac Coating System** – Epoxy novolac coatings such as Carboline Plasite 4550, International Ceilcote 2000 Flakeline, or an approved equal offer excellent resistance to chemicals and sulfuric acid. The application requires a two-step process after the concrete has been cleaned, abraded and resurfaced:

  1) Spray application of an epoxy primer at 2-5 mils.
  2) Spray application of the epoxy novolac coating at 20-25 mils.

Prior to the application of either coating system, the existing concrete should be abrasive blasted to remove deteriorated concrete. Any exposed reinforcing steel should be treated with a corrosion inhibitor such as Sika Armatec 110 EpoCem or approved equal. Then the concrete substrate should be resurfaced up to the approximate original surface by spray-applying or hand-applying a repair mortar such as Sika 223 or Sika 224 or approved equal. Note that if the repair mortar is spray-applied, the repair surface should be hand-finished to a surface suitable for coating.

Either of the two coating systems above will provide the unprotected concrete surfaces of the Influent Room with superior protection against biogenic corrosion. Both coating systems are compatible with the existing PVC T-Lock liner. The damaged T-Lock at the upper termination should be trimmed 6 inches. The Arrow-Lock should be tied to the existing T-Lock using weld strips. The epoxy novolac system should be overlapped 6 inches on top of the existing PVC T-Lock liner.

Table 5 compares the coating systems options for the Influent Room.

Table 5.
Comparison of Coating Rehabilitation Options

Factor	Arrow-Lock	Epoxy Novolac
Chemical and acid resistance	Yes (best)	Yes
Qualified applicators	Limited	More available
Down time required for application*	5 to 6 weeks	3 to 4 weeks
Estimate of probable construction cost per square foot (product and labor only)	$40	$30
Total estimate of probable construction cost for concrete and coating rehabilitation (product and labor only)	$73,000	$55,000

*Durations listed are based on a complete shut-down of the Influent Room and its availability for regular 8-hour workdays.

Due to the shut-down constraints of the IPS and the probable costs of bypass pumping, it is V&A's opinion that an epoxy novolac coating system would be the best option for rehabilitating the damaged concrete in the Influent Room.

Rehabilitation Feasibility Evaluation

Based on ICM's feasibility evaluation of the Influent Room rehabilitation, ICM presents the City with the following items to consider during the design, bidding and construction of the project:

Control of Wastewater Flows

- Concrete repair work in the Influent Room above the grating can be done without the need to stop or redirect wastewater flow. However, work to remove and replace grating, to coat grating support beams, and to repair concrete and T-lock located below the grating, will require work below the grating and consequently the need to control wastewater flows.
- Wastewater flow is measured by the plant SCADA system as wastewater pump flow rates into the old (north) and new (south) sections of the treatment plant. This represents the combined flow into the IPS from both the north and south trunk sewers. The City does not have data on the

individual flows entering the influent pump station from the North Trunk Sewer and the south trunk sewer.

- By visual observation during V&A's assessment, the north trunk sewer runs approximately 25% full and normally below the spring line. The south trunk sewer runs approximately 10% full and normally below the spring line. The north trunk sewer may discharge 75% of the total flow into the IPS, with the south trunk sewer discharging the remaining 25% of the flow.
- ICM has conceptualized three methods to manage the wastewater flow in the IPS to allow for work below the grating:
  - *Bypass Pumping*: A complete bypass pumping system that will handle all the influent flows into the IPS may be cost prohibitive. This bypass pumping system would have to handle 10 mgd or more. It potentially would require above-ground screening of solids.
    - Limited bypass pumping would be less costly. This type of bypass pumping would be used from midnight to 5 a.m. when flows are lowest and pumping requirements are the least. Flow would be intercepted at the north and south trunk sewer manholes next to the IPS, preventing flow entering the Influent Room. The flow would be directedto the bar screens before being pumped into the plant. Flow back into the Influent Room would be prevented with bulkheads.
    - A disadvantage of the limited bypass pumping method is the potential impact wastewater may have on the existing trunk sewers. Portions of the trunk sewers are severely deteriorated and flooding the trunk sewer may risk a failure of part of the pipe system. This scenario will be evaluated in more detail during the design to ascertain if limited bypass pumping may cause failure of the trunk sewer.
    - Another disadvantage of the limited bypass pumping method is the limited time the Contractor will be able to work below the grating. ICM is assuming that a limited bypass pumping system would be functioning between midnight and 5 a.m. providing a five-hour work window. Setup and take-down of bulkheads will cut short an already short work window. The time required to complete repairs below the grating will be evaluated during the design to determine the efficacy of limited bypass pumping.
  - *Flow-Through Plug*: A flow-thru plug for a 60-inch pipe is a specialty item. The idea is to insert and inflate the flow-thru plug into the 60-inch pipes. Flow thru piping would direct wastewater over a temporary bulkhead (to prevent flow from backing up into the Influent Room) and into the bar screens. One plug would be needed for the north trunk sewer and one for the south trunk sewer.
    - After contacting four Flow-Thru Plug suppliers who did not make a 60-inch Flow-Thru Plug that could handle WQCF flows, ICM located Stemar (800-992-0100). They provide a 60-inch Flow-Thru Plug with a 48-inch flow thru pipe. It rents at approximately $2,000 per week. However, it weighs more than 350 pounds and it may not fit through the Influent Room door, the largest opening into the Influent Room. During the design ICM will determine if it is feasible to use this or any flow-through plug on this project.
  - *Closing the Trunk Sewer Gates*: During the V&A assessment, WQCF staff closed the north and south trunk sewer gates in the Influent Room. The north trunk sewer gate closed with no leakage. The south trunk sewer gate closed with an estimated 5 gpm leakage.

- It is feasible to work below the grating in the Influent Room between the hours of midnight and 5 a.m. with the trunk sewer gates closed. A disadvantage of this method is the abbreviated work window. During the design ICM will determine the feasibility of increasing the work window by determining the storage capacity versus flow rate in the trunk sewers and by evaluating the use of limited bypass pumping to extend the work window.
- Another disadvantage of closing the trunk sewer gates is repair work behind the gates and around the trunk sewer penetrations cannot be performed while the gates are closed. In order to repair around the trunk sewer penetrations, another method to control wastewater flow is required.

Management of Hydrogen Sulfide Gases

- ❖ OSHA has set the construction worker safety limits for hydrogen sulfide gas as a permissible exposure for an 8 hour work day of 10 ppm or less. Exposure of 10 ppm to 50 ppm hydrogen sulfide gas is limited to one 10-minute exposure in an 8-hour work day. Immediate danger to life and health is 100 ppm. Asphyxiation can occur at concentrations above 500 ppm.
- ❖ Hydrogen sulfide gas is denser than air and can accumulate at low points. To remove hydrogen sulfide buildup, ventilation is used to maintain the gas at proper levels.
- ❖ There are no air-purifying cartridges for hydrogen sulfide gas that will permit work above the 10-ppm level. There are air-purifying cartridges that are designed for an emergency evacuation only. In order to work in an environment that has hydrogen sulfide gases above 10 ppm, the Contractor will have to use supplied air to its workers. Alternatively, the Contractor will have to ventilate and maintain the H_2S gas concentrations below 10 ppm.
- ❖ From May 11 to May 18, an OdaLog hydrogen sulfide gas monitor recorded hydrogen sulfide gas concentrations in the Influent Room. The OdaLog monitor was positioned two feet above the grating, adjacent to the north trunk sewer gate. Results are shown in Appendix B.
- ❖ Based on the OdaLog recordings from May 11 through May 18, 2012, hydrogen sulfide gases can be expected to be between a low of 9 ppm and a high of 184 ppm, with an average of 56 ppm. The lowest concentrations occur between 1:30 a.m. and 6:30 a.m. Highest concentrations occur between 7 a.m. and 10 a.m. and again from 7 p.m. to midnight. Hydrogen sulfide peaks occurred every 20 to 30 minutes, attributable to wastewater flows coming from the Lathrop pump station. It should be noted that hydrogen sulfide concentrations may fluctuate throughout the year as flows and temperature change.
- ❖ During V&A's assessment work, based on continual air monitoring, V&A was able to use forced-air ventilation to maintain a hydrogen sulfide concentration below 10 ppm during the preliminary daytime visit on April 27 and the nighttime (between 11:00 p.m. and 5:00 a.m.) visit on May 11. However, it was not possible with the equipment available at the time to maintain a hydrogen sulfide concentration below 10 ppm during the daytime visit on May 9. Spikes in hydrogen sulfide concentration up to 17 ppm occurred every 20 to 30 minutes (again, likely attributable to the Lathrop pump station cycles). The higher concentration of hydrogen sulfide on May 9 versus April 27 is likely due to the warmer ambient temperatures on May 9.

- In our opinion, it is feasible for the Contractor to use forced-air ventilation to maintain a safe work environment for its workers without resorting to supplied-air respirators. However, wastewater flow is variable and hydrogen sulfide concentrations will vary over time. It is possible for hydrogen sulfide concentrations to be higher than the recorded high of 184 ppm, and other influent pump stations have been known to have hydrogen sulfide concentrations in excess of 1000 ppm.
- Since the Contractor is in the best position to manage the IPS atmosphere and minimize risk to its workers, the construction contract should put the burden and risk of providing a safe work environment completely on the Contractor. The Contractor should be required to do the following:
  - Provide a safety plan that is as protective as or more protective than the City's safety plan.
  - The size, type, and location of ventilators and fans should be decided by the Contractor.
  - The Contractor should be responsible for air monitoring.
  - The Contractor should be responsible for maintaining a safe work environment for its workers, City staff, and ICM and V&A inspectors.
  - The Contractor should be responsible for providing a supplied air system for its workers, at no additional cost to the City.
  - The Contractor should be responsible for providing a supplied air system for City inspection personnel if they do not provide adequate ventilation for a safe entry without supplied air.
- To protect the City from a changed condition claim, the City should do the following:
  - The City should provide historical data, during the bidding process, in regards to wastewater flow and air monitoring results.
  - The City should allow the Contractor access through all hatches and doors for ventilation purposes, unless it impedes the function of the plant.
  - The City should coordinate and accommodate the Contractor's needs to maintain or shut off the IPS's foul air system.
  - The Contract should state that there will be no extra for handling the confined space atmosphere.

Influent Room Grating System (Update Using FRP Grating)

- *City Action Item*: The City should decide whether to keep the influent room grating system or remove it.
- In some small places, the grating has severe corrosion. In other locations, the grating is in fair condition. If the City would like to have a grating system in the Influent Room, it is recommended that the grating be replaced with fiber-reinforced polymer (FRP) gratings. The aluminum support beams that were evaluated are in fair condition and could possibly be salvaged if they are coated. Otherwise, the support beams should be replaced with FRP beams.

Influent Room Door

- *City Action Item*: The City should decide whether to keep a door into the Influent Room or seal the room.
- If a door is required for the Influent Room, it is recommended a PVC hatch with handles. The hatch would be bolted to the wall (outside the Influent Room) with stainless steel anchor bolts. The wall would receive a coating to prevent corrosion. The hatch would mount to the wall with a gasket. Details of the hatch system will be completed during the design phase.
- If the City decides to seal the Influent Room, then ICM suggests filling the doorway with concrete and providing an interior coating system integral with the Influent Room coating system.

Work Outside Influent Room

- During the design, the concrete and grating repair outside the Influent Room will be addressed if necessary. This repair is required around the bar screen area.

APPENDIX A:
CHRISTENSEN MATERIALS ENGINEERING
CONCRETE TESTING REPORT

Christensen Materials Engineering

Materials Consulting
Laboratory Testing
Failure Analysis

May 17, 2012 Project No. 12027

Mr. Noy Phannavong
V & A Engineering
155 Grand Avenue, Suite 700
Oakland, CA 94612

Re: Concrete Testing
Manteca Wastewater Treatment Plant – Influent Pump Station

Dear Mr. Phannavong:

Concrete core samples were tested from the Manteca Wastewater Treatment Plant – Influent Pump Station (IPS). The work was performed as part of the condition assessment being conducted by V&A Engineering. The cores were tested to determine compressive strength and to help evaluate the extent of concrete degradation that has occurred inside the influent room (IR).

Test Procedures & Results

1. Concrete Sampling

Concrete core samples were removed by drilling from the influent room roof slab and north wall. Cores 1 and 2 were taken from the roof slab and core 3 was from the north wall, as shown in the attached drawing. Photo 1 shows the core samples.

2. Concrete Core Compressive Strength

Cores 2 and 3 were tested for compressive strength in accordance with ASTM C42 (Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete).

TABLE 1. CONCRETE COMPRESSIVE STRENGTH RESULTS

Sample No.	Diameter (in.)	Capped Height (in.)	Area (sq. in.)	Max. Load (lbs.)	Compressive Strength (psi)
2 (Roof)	3.71	7.14	10.80	64,200	5910*
3 (N. Wall)	3.71	6.84	10.80	53,350	4880*

*Compressive strength corrected for l/d less than 1.8 per ASTM C42.

3. Macro-Sections & Depth of Surface Deterioration

Macro-sections were prepared from cores 2 and 3. This entailed saw cutting/splitting the cores and staining with a pH indicator solution (phenolphthalein) to evaluate the extent of surface deterioration to the concrete.

Phenolphthalein indicator turns pink at greater than pH 10 and is colorless at less than pH 10. Normal concrete is pH 12 and therefore should turn pink when treated with the phenolphthalein indicator. Colorless areas have reduced pH and occur at the surface exposed to influent where deterioration has occurred.

Roof Slab Core 2

Measurements from the macro-section indicate 13 inches of sound concrete at the roof core 2 sample location. See Photos 2 and 3. The drawings provided indicate the roof slab is 12 inches thick. Clearly, the as-built roof slab is thicker than 12 inches. Since we don't know the original slab thickness, we cannot accurately determine the extent of degradation.

Wall Core 3

Persistently high levels of hydrogen sulfide in the confined space work area caused delays during core drilling which did not allow enough time to obtain a through-wall core from location 3. Core 3 was broken off at a depth of 20¼ inches (the IR wall thickness is 24 inches), before reaching the inside surface of the IR. There was sound concrete in the wall to the 20¼ inch depth drilled. See Photo 4.

Conclusions

1. There is 13 inches of sound concrete in the IR roof slab at core location 2. There is greater than 20¼ inches of sound concrete in the IR wall at core location 3.

2. The concrete has good strength (5910 psi at the roof slab and 4880 psi at the north wall).

Respectfully submitted,

CHRISTENSEN MATERIALS ENGINEERING

Conrad Christensen, P.E.
Metallurgical/Materials Engineer

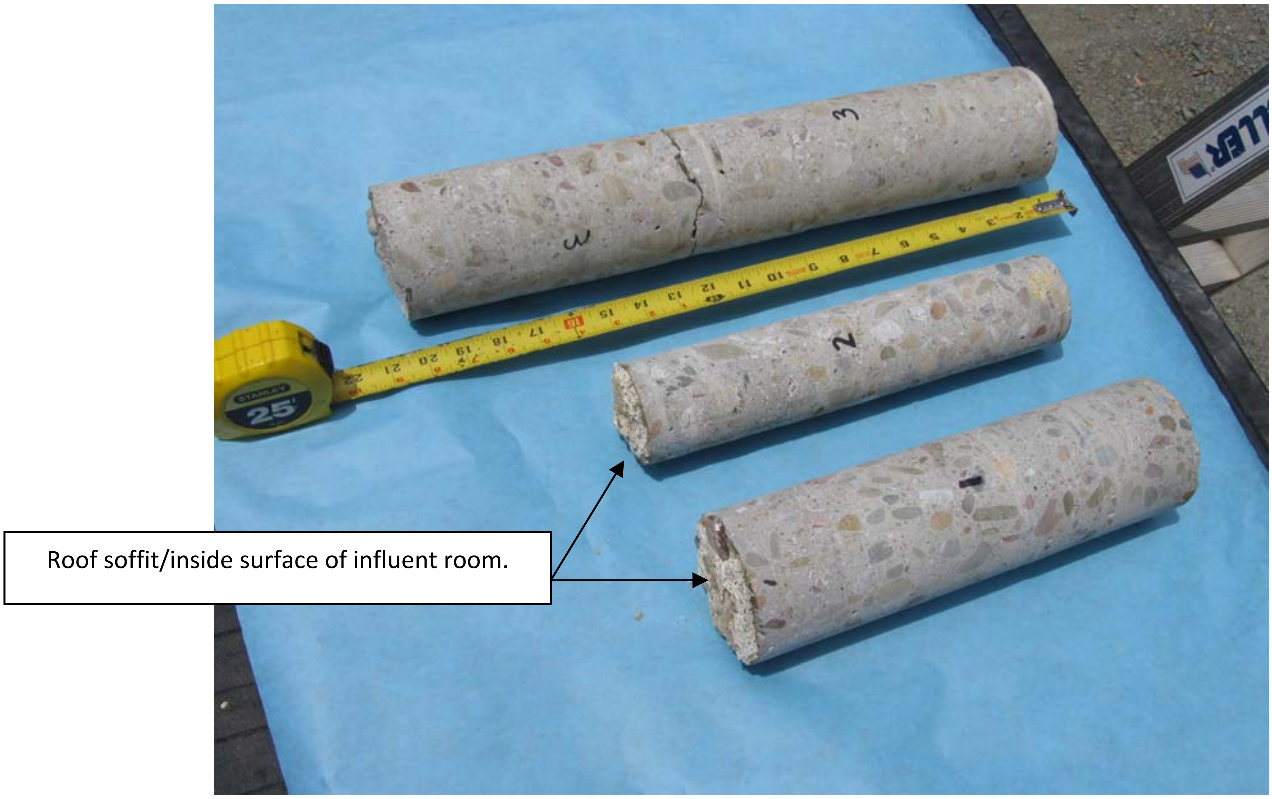


Photo 1) Core samples 1-3. Cores 1 & 2 are from the IR roof and core 3 is from the north wall.

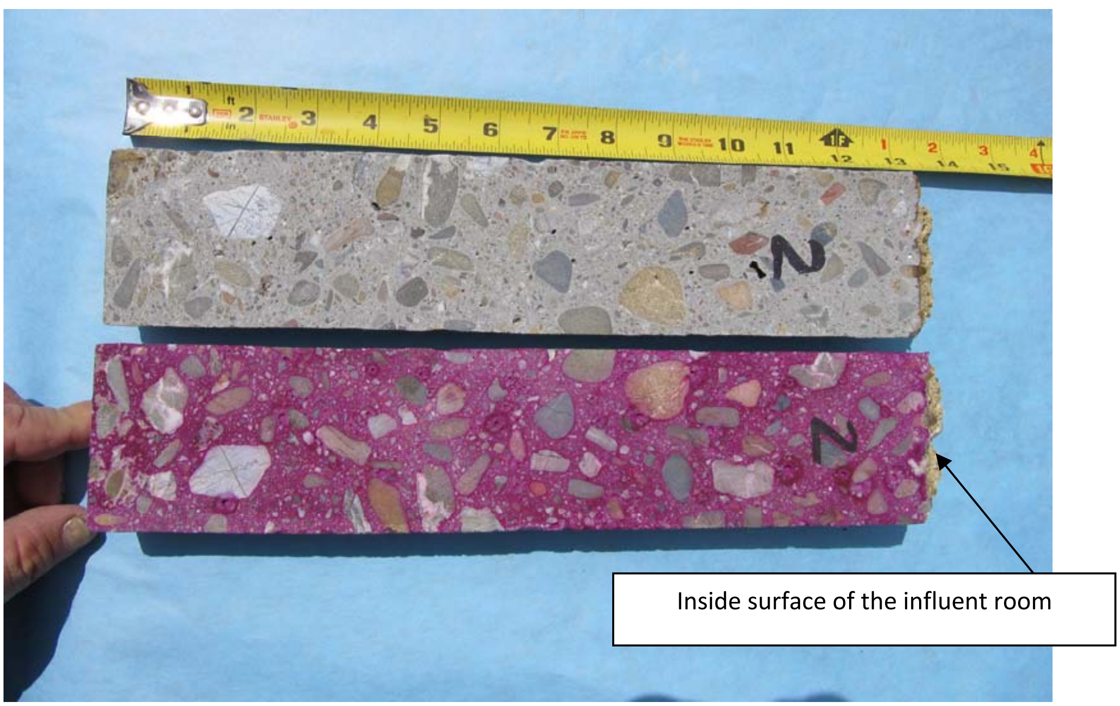


Photo 2) Macro-section prepared from roof slab core 2. The lower half of the core was stained with pH indicator (phenolphthalein). There is 13 inches of sound concrete in the roof slab at this location.

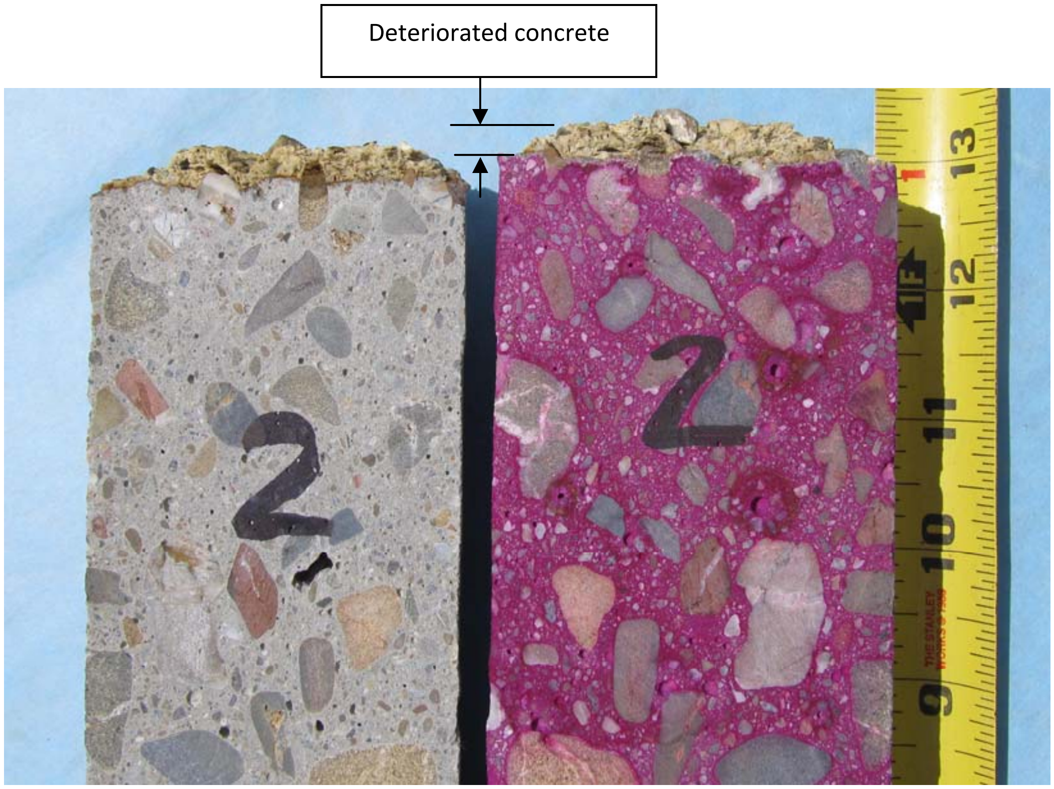


Photo 3) Close-up of Photo 2.

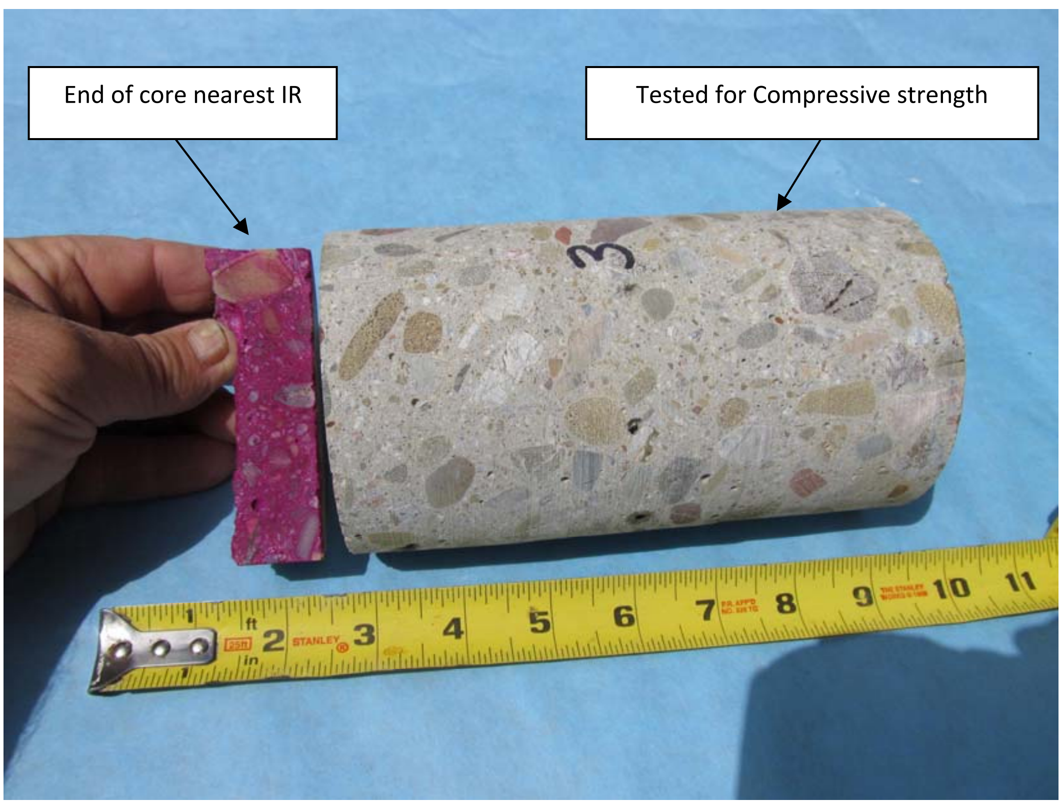
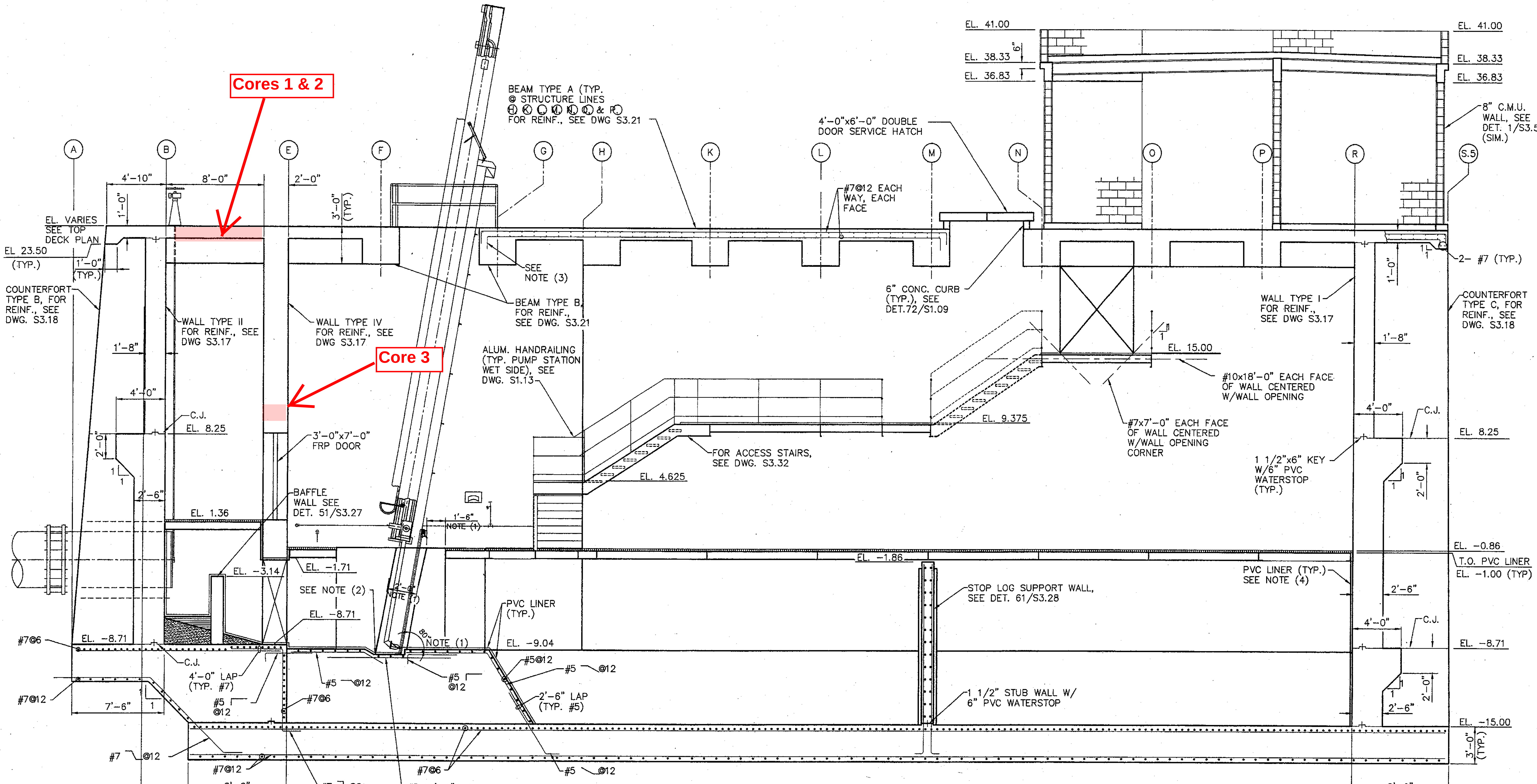


Photo 4) Wall core 3 was cut/trimmed as shown and the portion nearest the IR was stained with pH indicator solution (phenolphthalein). There is sound concrete to the 20¼" drilled depth of the core.



SECTION A

S3.01 S3.02 S3.03 S3.04 S3.05 S3.06 S3.07 S3.08 S3.50 S3.51

NOTES:

(1) WALL RECESS FOR MECHANICAL BAR SCREEN. VERIFY LAYOUT DIMENSIONS WITH EQUIPMENT MANUFACTURER. SEE DET. 59/S3.27 FOR REINF. AROUND RECESS.

(2) PROVIDE SLAB RECESS PER MANUFACTURER REQUIREMENTS.

(3) TERMINATE TOP DECK REINF. WITH STANDARD HOOKS AT OPENINGS IN TOP DECK AND AT DECK EDGE (TYP.)

(4) PROVIDE PVC LINER ON WALLS OF PUMP STATION WET SIDE FROM INVERT TO EL. -1.00. ALSO PROVIDE PVC LINER ON FILLET SLOPES AND INVERTS AS SHOWN. FOR LINER DETAILS SEE DET.70/S1.09

CAUTION: The engineer preparing these plans will not be responsible for, or liable for, unauthorized changes to or uses of these plans. All changes to the plans must be in writing and must be approved by preparer of these plans.

\\SAS1\PROJECT_N\SA1224\EXPANSION\SCHEDULE-B\Cadd\Structural\SCH-BS310.DWG 07/14/03 1:49 p.m.

NOLTE BEYOND ENGINEERING

302 CHERRY LANE, SUITE 201, MANTECA, CA 95337 (209) 239-9080

DATE: JULY 2003
PROJECT NO.: SA1224
DRAWN BY: K.D. SQUIRES
CHECKED BY: S.L. HIATT
PROJ. MGR.: D. RICHARD
PROJ. ENGR.: M.A. PUGH

NO.	BY	DATE	REVISIONS

REDUCED CONFORMED SET NOT SCALE

MANTECA WASTEWATER QUALITY CONTROL FACILITY
PHASE III EXPANSION PROJECT - SCHEDULE B - SOUTHSIDE FACILITIES

STRUCTURAL

INFLUENT PUMP STATION-HEADWORKS STRUCTURE SECTION A

SCALE 1/4"=1'-0"

DRAWING NUMBER S3.10

SHEET NUMBER OF SHEETS

APPENDIX B:
Hydrogen Sulfide Concentrations

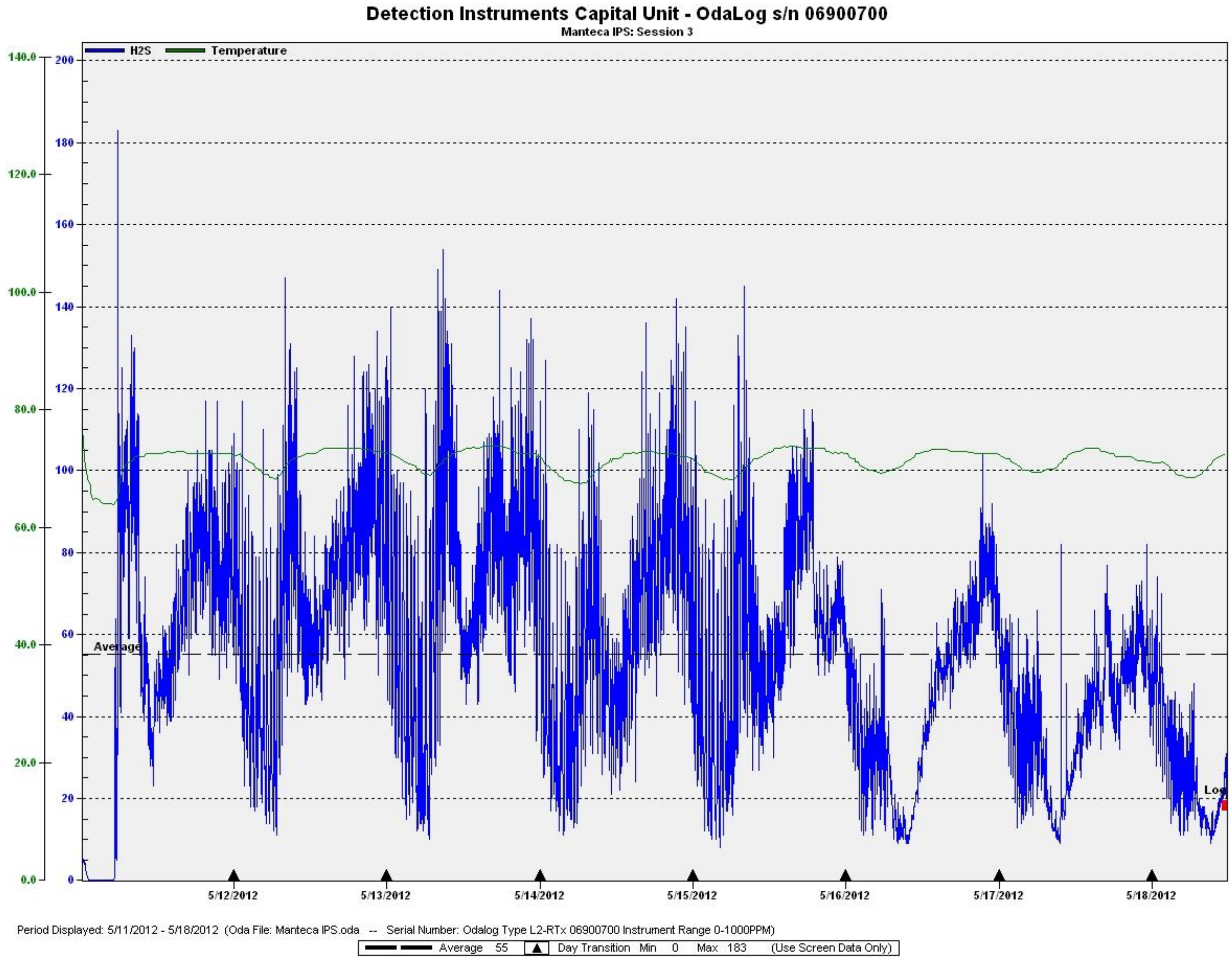


Figure B-1. Hydrogen Sulfide Concentrations in Influent Room, May 11 Through 18