RECLAMATION

Managing Water in the West

Underwater Cure Polymeric Repair Field Demonstration

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Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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14. ABSTRACT The Concrete, Geotechnical and Structural Laboratory conducted an underwater field demonstration of injected polymeric grouts in a nominal 1 inch crack on a canal in the Central Arizona Project following successful lab testing. Two different types of grout was injected underwater with the support of commercial divers. The grout was premixed at the injection nozzle with varying temperatures of mix water to optimize curing time for successful sealing of the cracks. The results showed that one grout performed better than the other and that an optimal mix water temperature can be used.					
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Executive Summary

The underwater sealing of seepage cracks research that the Reclamation Concrete, Geotechnical, and Structural Laboratory group (CGSL) conducted in FY15 has gained a lot of interest (Harrell, P.E. & Klein, P.E., Ph.D., 2015). This lab study was conducted to determine if polymeric grouts could be injected directly into a premade crack without having to use the traditional delivery method of dewatering, drilling port holes to intersect the cracks, and injecting the grout into the cracks thru the port holes. The intent of that research was to simulate the pressures and flow experienced in a 12 foot deep canal and try to cure the grout in the crack. The results of the 2015 research found that certain hydrophilic grouts performed well in the underwater injection conditions.

This field demonstration utilized a contracted commercial certified diver to conduct the same tests in actual service conditions. The grouts identified in the 2015 laboratory study were used: Strata-Tech ST-504 and Avanti AV-330. The 2015 research found that one of the key issues with underwater grout injection was curing the grout sufficiently to adhere to the crack fracture plane instead of flowing through the crack. This field demonstration tested the ease of underwater injection, premixing the grout to initialize the curing before injection, and varying the premixed water temperature to optimize curing times. The following tests were performed in cracks identified as inactive (no water leaking through the crack):

Strata-Tech ST-504

- Test 1 - No premix water
- Test 2 through 7 – 80 degrees F, 90 degrees F, 100 degrees F, 110 degrees F, 120 degrees F, and 180 degrees F premix water

Avanti AV-330

- Test 1 - No premix water
- Test 2 through 5 - 80 degrees F, 100 degrees F, 120 degrees F, and 180 degrees F premix water

The field study was a success. Both chemical grouts performed better by premixing the grout prior to injection. Introducing heated water also had a direct impact on the curing performance, yielding an optimal premix water temperature:

- The Strata-Tech ST-504 performed optimally when premixed with 120 degrees F water.
- Avanti AV-330 performed optimally when premixed with 80 degrees F water during high canal flow velocity (500 cfs) and when injected without premix water during low canal flow velocities (less than 200 cfs).

Upon the successful completion of this field demonstration, Reclamation recommends that further investigations be conducted on active leaking cracks. In addition, Reclamation recommends that core samples be taken of the sealed crack to quantitatively analyze the performance of the grout for adhesion and penetration.

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Background

Previous and Ongoing Reclamation Research

The Research and Development Office through the Science and Technology program funded the Concrete, Geotechnical, and Structural Laboratory Group in 2015 to study underwater applications of polymeric grouts to seal seepage cracks. Polymeric grouts are injectable liquid resins that when mixed with water, react chemically to form either a flexible foam or a rigid foam. Flexible foams are used to seal cracks in concrete to stop water leaks. Rigid foams are often used as soil stabilizers. There are two kinds of polyurethane grouts, hydrophobic and hydrophilic grouts. Hydrophobic grouts require a catalyst and typically have a larger expansion than hydrophilic grouts. Hydrophilic grouts seek out water in cracks and usually form a flexible foam. The seal forms when chemical grout expands in a crack creating compressive forces which mechanically lock the grout into place. Both grouts used in this study are ANSI/NSF Standard 61 potable water systems UL certified for contact with potable water.

Traditionally, grout injection procedures require a series of regularly spaced injection channels to be drilled into the concrete on a line parallel with the crack and offset so that the channel intersects the cracks at the concrete element midpoint. Check valve ports are fixed to the entrance of the channels and resin would be injected into the ports until one of three conditions are met: 1) the resin escapes out of an adjacent port, 2) resin ejects from the crack or 3) maximum injection pressure is reached. This procedure requires dewatering of the tunnel or canal to perform the work. The objective of the 2015 research was to see if chemical grout could be injected directly over the crack allowing gravity, pressure and water flowing through the crack to direct the grout into the crack. The research indicated that polymeric grouts had potential of being applied underwater to seal seepage cracks without having to dewater the water control structure. (Harrell, P.E. & Klein, P.E., Ph.D., 2015)

The 2015 research indicated that the hydrophilic grouts were the best at sealing the cracks, but the hydrophobic grouts had better visibility (i.e. didn't cloudy the water) when injected underwater. However, the hydrophobic grouts had an issue of becoming buoyant once reacted with water. The Concrete, Geotechnical, and Structural Laboratory Group, has continued the underwater applications study in a laboratory environment. The objective of the 2016 research is to see if combining the hydrophobic grouts with the hydrophilic grouts would seal the crack and improve visibility. This research is ongoing.

Other Underwater Grouting Operations

There are few companies claiming to perform underwater crack repairs without drilling or dewatering. However, they have not been widely documented. Concrete Experts, based in Seattle, WA, advertise an underwater repair program on YouTube. The video demonstrates their underwater inspection and repair process, but their website did not provide any other documentation, white papers or case studies. (Concrete Crack Repair and Coating Specialists, 2016)

Arizona Commercial Diving Services provided their services for this project and had also performed similar underwater injection service. However, they drilled through the canal lining to inject grout behind the panels to perform soil stabilization and prevent seepage. They had not used a premixing injection nozzle to premix the grout with water prior to this demonstration.

Heating the chemical grout so that it reacts faster is not a new concept. HyperFlex polyurethane grout by SealGuard Inc, recommends heating the cartridges of grout to at least 70 degrees F by placing them in hot water (HyperFlex Water Sealant, 2016). Graco has a pump that heats the grout prior injecting along with insulated hoses so that the grout remains warm as it goes through the grout lines (Graco, 2015).

Demonstration Site

CAP is a massive water distribution project located in Maricopa, Pima, and Pinal counties in Arizona. The purpose of the project is to divert Colorado River water for agricultural, municipal and industrial use, as well as power generation. One of the distribution canals, located in Pool 33 near Casa Grande, Arizona, experienced about 20 feet of cracking in two of the concrete lining panels. In October 2015, a leak had been detected on the west side of the canal and the seepage was sealed using a cementitious grout injected in the soil embankment. The cracks on the east side were sealed using an underwater epoxy, Carboline A-788. Additional cracks were identified on the right side but they did not have an active leak (Schumacher, 2013).

Site Conditions

The field demonstration was performed February 2 and 3, 2016. The ambient air temperature was 33 degrees F in the morning when testing commenced and reached a high for the day of 52 degrees F. The canal water temperature was a constant 45 degrees F. The sky was sunny and there was only a very light breeze.

Goals for the Project

Laboratory studies indicated that there was potential that chemical grouts could be injected underwater to seal seepage cracks. This field demonstration was the first of its kind using this underwater application of chemical grout by Reclamation. The goals of this project were to:

1) Demonstrate if polymeric grout could be injected into cracks in the concrete panels while the canal was in service.
2) Determine if premixing the grout in an injection nozzle would help to sufficiently initiate the curing reaction and allow the grout to set up in the crack.
3) Determine if heating the premix water can reduce the set time and if an optimal mix temperature can be determined.

Items 2 and 3 above were not part of the original laboratory study, but the team felt it was important to get the chemical grout to react as soon as possible based on the results from the laboratory testing.

Conclusions

- Both grouts performed better when premixed with water in the injection nozzle prior to injection.
- Premixing with heated water reacted the grout faster. This gave the grout sufficient time to adhere to the crack surface before being swept downstream leading to less product waste.
- ST-504 performed optimally when mixed with water at 120 degrees F.
- AV-330 performed optimally when mixed with water at 80 degrees F.
- Observations of AV-330 after 24 hours indicated that the best penetration and adhesion occurred when the grout was injected without premixing only during low water flow (less than 200 cfs). When the water flow was higher (500 cfs), the best penetration and adhesion occurred when the grout was premixed with 80 degree F water.
- 180 degree F premix water caused near instantaneous particle curing that did not adhere well in the crack for either product.
- The diver preferred AV-330 over ST-504 because it seemed to have better adhesion, penetration and felt firmer.

Equipment

Some of the equipment used was supplied and operated by the contractor, Arizona Commercial Diving Services. Their equipment included generators, hot water heater, grout and water pumps, surface-supplied diving gear and mobile command center for communication and recording video and audio. Reclamation supplied the premixing nozzle also known as an “F”-assembly. CAP provided equipment and materials for marking the locations of the test on the sides of the canal.

The hot water heater was used to heat the premix water to different temperatures to determine the optimal temperature or range for initiating curing so that the grout would adhere sufficiently to the crack and not be washed downstream.

Figure 1 shows the hot water system that was used on this project. The water heater is also used to supply hot water to the diver’s wetsuits to keep the divers warm in the 45 degrees F canal water.

Figure 1 - Water heater and generator for heating premix water

The pumps shown in Figure 2 were used to pump the polymeric grout and premix water. The pumps were airless paint sprayers found at local hardware and home improvement stores. The pumps feature a power switch, pressure knob, recirculating valve and prime button. The intake and recirculate hose is placed in a bucket with either grout or water and the pump turned on while the pressure knob is turned down. The recirculating valve is turned to recirculate and the prime button pressed once. The pump is primed by increasing the pressure knob to start the pump until material can be seen flowing through the clear intake hose returning to the bucket. Once the pump is primed, flow through the injection hose is verified.

Figure 2 – Airless paint sprayer and hoses for pumping grout and premix water

Arizona Commercial Diving Services were responsible for managing and directing the dives in collaboration with CAP and Reclamation. They conducted safety meetings related to the dive separately from the project safety meetings. Two divers were supplied for every dive and two support staff assisting from the edge of the canal. A primary diver performed the grout injection and a secondary diver assisted with hose payout, additional video and primary diver support. Both divers were equipped with tethered video cameras and microphones for achival recording and communication with the command center. The same diver performed the injection throughout the demonstration to keep injection procedures the same.

Figure 3 - Commercial diver preparing for the dive

The mobile command center was equipped with video monitors, audio communication, recording equipment, and a dive chief responsible for monitoring the divers and diving mission. The monitors provided real-time video from the diver's cameras. Instructions and feedback could be relayed from the divers and the dive chief using the commication system.

Figure 4 - Mobile command center setup

Reclamation supplied several injection assemblies which were assembled and brought with the TSC staff to the field demonstration. Figure 5 (a) nozzle was used to inject grout only. Water is not mixed with the grout in this nozzle configuration. This nozzle was used the first day with the ST-504 product in tests 1a and 1b and on the second day with the AV-330 product in test 1. The nozzles pictured in Figure 5(b) show two different F-assemblies. In this configuration, water is connected to the back of the assembly (red or blue ball valve pictured) and the grout supply is connected to the forward valve (yellow or black ball valve pictured). The water line is always connected to the rear of the assemble to be able to flush the mixing tube and nozzle. It is important to keep the water line hooked up at the back of the assembly so that the water can flush the entire line and keep grout from setting up in the line. The (b) assemblies were used in all other testing on this project. The injection nozzle pictured in Figure 5 (c) was only used in the laboratory testing and was not used in the field demonstration. The grease fitting connectors at the ends of the assemblies were also removed during the demonstration.

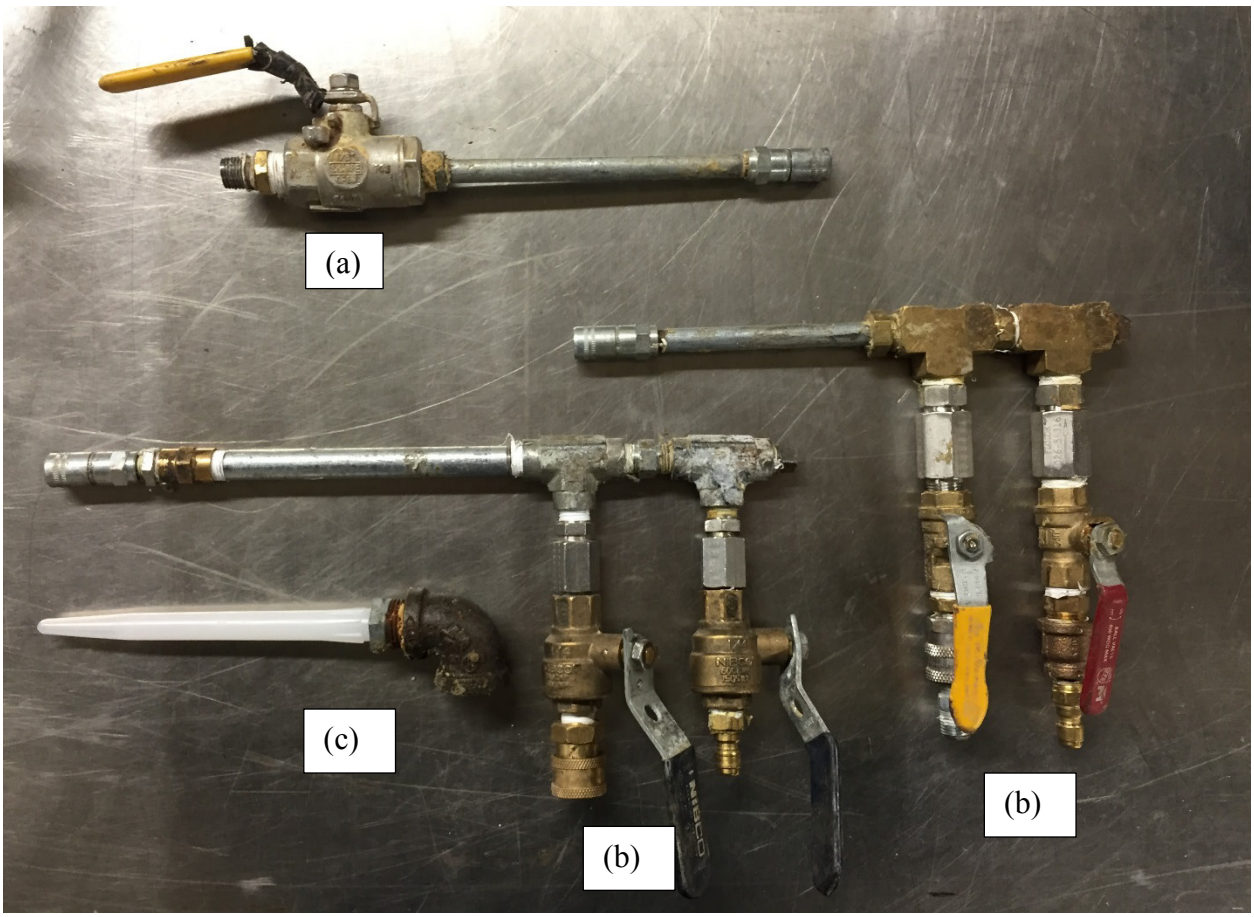

Figure 5 – (a) Single component injection assembly with grease fitting connector (b) F-assemblies with grease fitting connector (c) injection nozzle used in lab study

CAP staff marked the field demonstration sites with stakes so that the location of the demonstration was clearly identified for future performance inspections. The stakes consisted of rebar with an orange ribbon flag located on the left side edge of the canal embankment and road looking downstream.

Figure 6 – CAP staff marking the location of the tests

Methods

The field testing is intended to determine the ease at which polymeric grouts can be injected underwater and if the grout will flow into the concrete canal lining panel cracks, if premix water added to the grout prior to injecting will decrease cure time and prevent the washing away of the grout before it has adhered to the crack and if the premix water temperature can be optimized to control the curing time of the grout to maximize adhesion and penetration in the crack.

Prior to the tests, a catch line was setup downstream so that any cured resin that might not adhere to the crack, would be captured and removed from the canal for disposal. Although each of the products being used are NSF 61 certified, it was easy to remove the floating reacted grout at this point. In addition, cup tests were performed on the grout products to determine the initial set times using a 1:1 ratio. Figure 7 shows the two products approximately 3 hours after the cup tests were performed. ST-504 has been consistently shrinking in cup tests performed on other projects. The manufacturer has been contacted about this issue and explained that the product only shrinks during unconfined cup tests.

Figure 7 - Cup Test (AV 330 left; ST-504 right)

The two products being tested in this demonstration are Strata Tech ST-504 hydrophilic vari-gel injection resin and Avanti International AV 330 Safeguard hydrophilic polyurethane foam. These products were recommended for field testing based on laboratory testing performed by Reclamation in 2015. The products were chosen because they did not disperse and float upon immersion in the water but adhered to the concrete to cure.

The sample grout was delivered to CAP and was left out overnight at about 40 degree F. Initially the dive team had difficulties priming the grout pumps due to the high viscosity until the grout warmed sufficiently. It was recommended to keep the grout at 50 degrees F or above to avoid having to warm up the grout.

The following test cases were conducted using ST-504 on approximately two foot sections of the crack per test. The crack width varied, but on average was about 1" wide. Figure 8 shows the crack prior to grout injection. Test 1a (2a) and 1b (2b) were tested at one foot lengths each so that a total of two feet was tested for those cases.

Figure 8 - Typical crack width

1. Tests 1a and 1b were conducted using the single component nozzle pictured in Figure 5 (a) (i.e. no mixing water).
    a. Test 1a tested holding the nozzle over the crack and let the grout flow into the crack.
    b. Test 1b tested inserting the nozzle in the crack.
2. Attached the F-assembly and injected the grout with premix water that was at 80 degrees F[1].
    a. Test 2a had the grease fitting on, but it was determined that the fitting created high pressure that did not allow the grout to adhere to the crack
    b. Test 2b removed the grease fitting.

[1] Measured at the pump, not at the nozzle. It was estimated that about 20°F was lost between the pump and nozzle.

3. F-assembly was used and the water was heated to 90 degrees F.
4. F-assembly was used and the water was heated to 100 degrees F.
5. F-assembly was used and the water was heated to 110 degrees F.
6. F-assembly was used and the water was heated to 120 degrees F.
7. F-assembly was used and the water was heated to 180 degrees F.

The following test cases were conducted using AV-330 on approximately two foot sections of the crack per test. Based on the results from ST-504, there was very little change in behavior for 10 degrees F increments of temperature change. Therefore, the mix water temperature increments were increased to 20 degrees F.

1. Single component nozzle pictured in Figure 5 (a) (i.e. no mixing water).
2. Attached the F- assembly and injected the grout with premix water that was at 80 degrees F.
3. F-assembly was used and the water was heated to 100 degrees F.
4. F-assembly was used and the water was heated to 120 degrees F.
5. F-assembly was used and the water was heated to 180 degrees F.

A complete description of the injection procedure can be found in Appendix A: Injection Procedure.

Results

The ultimate objective of this field demonstration was to effectively seal the crack in the concrete canal lining. Table 1 and Table 2 summarize the grout performance by product.

Table 1 - Summary of ST-504 Results

Test No.	Mixing Water	Test Section Length	Approx. Crack Width	Injection Observations	24 hour Visual Inspection	Figure
1a	no premix water	1'-0"	½"-¾"	The product had a slow reaction time. The product flowed out of the crack before it reacted and adhered to the canal wall below the crack.	There was little penetration of the product into the crack.	Figure 9
1b	no premix water	1'-0"	½"-¾"	The crack had a slow reaction time. The unreacted product flowed slowly out of the crack and down the face of the canal.	There was little penetration of the product into the crack.	Figure 9
2a	80° F Water	1'-0"	¾"-1"	The grease fitting was on the injection nozzle which created high pressure that blew the grout back out of the crack.	Such a small area was tested with the grease fitting on that it was not clear where 2a and 2b started and stopped. However, despite the feedback, this method is not recommended.	Figure 10
2b	80° F Water	1'-0"	¾"-1"	Product reacted quickly with the water and appeared to infiltrate and adhere to the crack much better than tests 1a and 1b	The product had good expansion and adhesion to the crack.	Figure 10
3	90° F Water	2'-0"	¾"-1"	Product had a faster reaction time than test 2b. There was less product that flowed out of the crack and adhered to the wall than test 2b.	The product had similar expansion and adhesion to the crack as test 2b.	Figure 11
4	100° F Water	2'-0"	¾"-1"	Product had a faster reaction time than test 3. There was little product that came out of the crack.	The product appeared more gelatinous and had little strength and adhesion.	Figure 12

Test No.	Mixing Water	Test Section Length	Approx. Crack Width	Injection Observations	24 hour Visual Inspection	Figure
5	110° F Water	2'-0"	¾"-1"	The flow in the canal began to increase during this test. There was very little product that came out of the crack.	The product was gelatinous. There were no gaps and appeared to have good penetration and adhesion. The product could be broken off easily in chunks similar to test 4.	Figure 13
6	120° F Water	2'-0"	¾"-1"	The product filled the crack better than test 5. Diver liked 120° F water the best.	The product had good penetration and no gaps. Product felt more solid than the gelatinous product from the previous two tests.	Figure 14
7	180° F Water	2'-0"	¾" – 1" and crack is offset approx. ½"	An excessive amount of product flows out of the cracks. The behavior was similar to what was observed during test 3.	The product did not have much penetration and was gelatinous.	Figure 15[2]

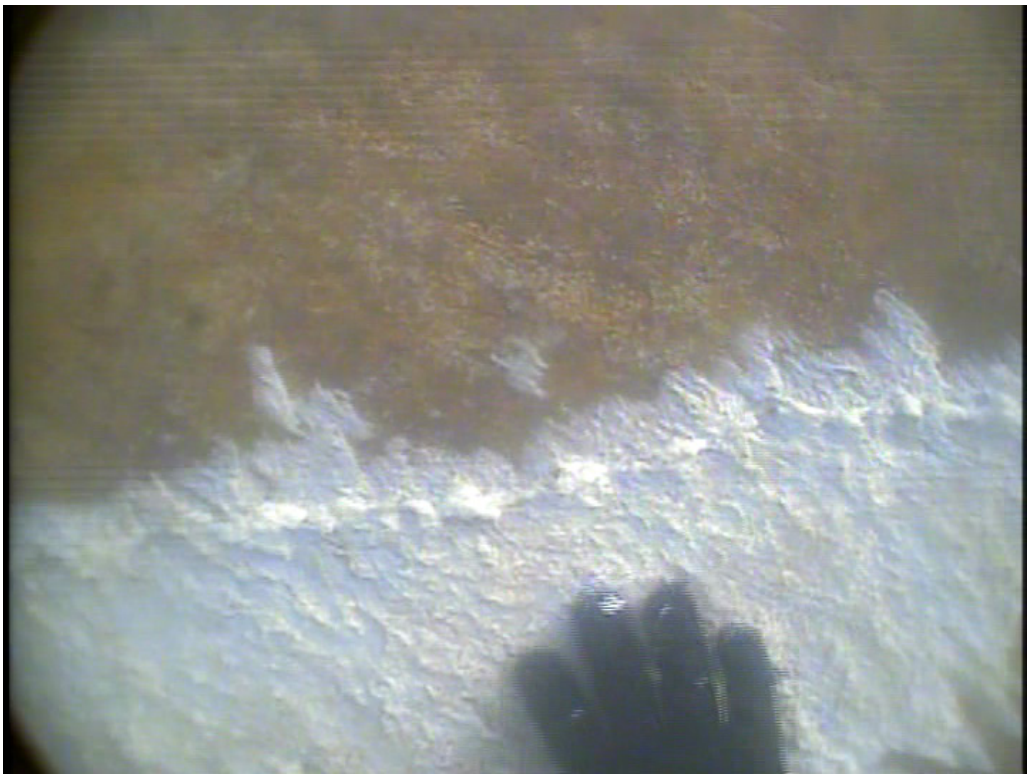

Figure 9 - ST-504 Test 1 after 24 hours

[2]Additional photos can be found in Appendix C.

Figure 10 - ST-504 Test 2 after 24 hours

Figure 11 - ST-504 Test 3 after 24 hours

Figure 12 - ST-504 Test 4 after 24 hours

Figure 13 - ST-504 Test 5 after 24 hours

Figure 14 - ST-504 Test 6 after 24 hours

Figure 15 - ST-504 Test 7 after 24 hours

Table 2- Summary of AV-330 Results

Test No.	Mixing Water	Test Section Length	Approx. Crack Width	Injection Observations	24 hour Visual Inspection	Figure
1	no premix water	2'-0"	1"	There was little to no runoff of the product when first injected.	There were no gaps and good penetration and bond to the crack. Cured grout was firm but flexible. Product was difficult to pull out of crack (good adhesion). Diver commented that for low flow conditions (less than 200 cfs), this procedure appears best.	Figure 16
2	80° F Water	2'-0"	1"	There was an increase in runoff down the face of the canal panels from test 1. Product became stringy as it cured.	Product had good penetration and bond. Cured grout was firm but flexible. Diver commented that in high flow conditions (500 cfs), 80° water premix water appears best.	Figure 17
3	100° F Water	2'-0"	¾"-1"	Product had a quick reaction time. There was some runoff down the face of the canal. Product became very stringy as it cured.	There was moderate penetration and no gaps. The product cured faster than test 1 and 2. The product had a Gooey bond and setup. Product was easy to pull out of the crack (low adhesion).	Figure 18
4	120° F Water	2'-0"	¾"-1"	Product had a quick reaction time. There was similar runoff to test 3. Product became very stringy as it cured.	There was poor penetration. Product was easy to pull out of crack (low adhesion).	Figure 19
5	180° F Water	2'-0"	½"- ¾"	Product reacted very quickly. The product had less penetration than the previous 4 tests.	There was poor penetration. Product had good bond to crack.	Figure 20

Figure 16 - AV-330 Test 1 after 24 hours

Figure 17 - AV-330 Test 2 after 24 hours

Figure 18 - AV-330 Test 3 after 24 hours

Figure 19 - AV-330 Test 4 after 24 hours

Figure 20 - AV-330 Test 5 after 24 hours

Future Recommendations

The field demonstration showed that both products tested, ST-530 and AV-330, could adhere and penetrate underwater cracks successfully. The results also indicated that premixing the grout with water and heating the premix water helps to improve curing performance to optimize adhesion and penetration in colder canal environments. However, the following observations are recommended to determine if underwater injection of chemical grout is a long term solution.

- Test hydrophilic and hydrophobic grout combinations for enhanced properties for underwater applications to improve flexibility and reduce shrinkage.
- Test on active leaking cracks. Reclamation will continue to communicate with CAP for opportunities to demonstrate the products for sealing active crack leaks.
- Obtain core samples over the sealed crack to quantitatively test adhesion and penetration of the grout.

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Appendices

Appendix A:
Injection Procedure

Injection Procedure-

1. Pressure was the crack prior to injection of the grout to remove any loose debris.
2. Ensure grout temperature of at least 50^{o} F. Room temperature is preferred.
3. Attach an F-assembly to the hose from the water and the grout pump. The water line should be attached at the back port of the assembly to flush the grout to clean out the injection nozzle.
4. Warm the premix water to the desired temperature.
5. Start injection process by first opening the grout line so that the grout flows at the desired rate.
6. Once grout is flowing properly, open the water line. Adjust valves to desired rates.
7. Hold the injection nozzle over the top of the crack. Fill the crack by injecting from downstream to upstream so that any excess product will flow downstream. This will also leave any unfilled crack visible.
8. Once the crack has been filled, close the grout valve. Open the water valve all the way to clear out grout. Direct the nozzle away from the crack so not to inadvertently clear grout from the crack.

Notes:

1) If possible, decrease water flow in the canal. Higher flows make it difficult for the diver to operate. It also has potential of washing the grout out of the crack before it has time to cure.
2) Do not use grease fittings on the nozzle. The fitting provides too much pressure that will blow the grout out of the crack.

Appendix B:

Technical Data Sheets

ST-504

VARI-GEL INJECTION RESIN

INTRODUCTION

Stratathane ST-504 Vari-Gel Injection Resin is a solvent-free, MDI-based water control and soil stabilization system. ST-504 is hydrophilic and reacts with water to form either a flexible gel or an elastomeric foam depending on the amount of reaction water added to the mix.

Stratathane ST-504 contains no measurable amount of TDI as performed by the Modified Analysis for Diisocyanates. ST-504 is non-flammable, non-carcinogenic, and non-corrosive as defined by 40 CFR and as described in the *NIOSH Pocket Guide for Hazardous Materials.*

ST-504 has NSF 61 approval for potable water contact and carries the Underwriters Laboratories UL seal.

Stratathane ST-504 is mixed with water at the work site to form a single injection material. The inert end product forms a water barrier which is essentially unaffected by acids, gasses, and organisms usually found in soil. A minimum of water (around 5% by volume) is needed for a reaction to occur, but large amounts can be accommodated through reaction or displacement.

Stratathane ST-504 is useful for a wide range of water control and soil stabilization applications, including grout curtains, stabilizing water-bearing soils, and sealing cracks or joints in concrete walls, buildings, dams and utility vaults.

Stratathane ST-504 may be placed by hand pumps or multi- ratio power pumps. Stainless steel fittings are recommended but not strictly required because ST-504 is no more corrosive than water. Cleanup of solidified material in the system, however, is often accomplished with caustic cleaning compounds, making stainless steel advisable.

The low viscosity of ST-504 makes it easy to inject. Once cured, its impermeability makes it an effective water shut-off system. The permeability of soil grouted with ST-504 depends on how well its voids are filled with grout. Values in the 10-7 cm/sec range should be obtained using *ASTM Constant Head Permeability Test Method D-2434.*

A three stage reaction takes place when ST-504 mixes with an equal volume of water and foams. The mixture first thickens and becomes creamy. Then, carbon dioxide gas evolves rapidly and the mixture expands as it cures. The expanded ST-504 volume then sets into a strong impermeable water barrier. Unrestrained ST-504 foam may expand up to 10 times its starting volume depending upon the degree of confinement applied to the expanding mass.

When ST-504 mixes with a large volume of water (i.e. 10:1 or greater), the three stages of the foam reaction cycle are not visible in the reacting mass. Instead, a marked viscosity increase will be seen just before the mass solidifies.

The reaction sequence with water takes place continuously during injection as product exits the packer. Initial penetration of the ST-504 grout mixture is facilitated by its low viscosity. After setting (in the case of the foam sequence), the expansive mixture pressure induces further filling of the grout zone. An ST-504 seal will tolerate freeze-thaw, wet-dry cycling, extrusion, and compression to a substantial degree.

DESCRIPTION

Uncured ST-504 is a dark brown liquid with a viscosity of about 700 cps at 25 C (77 F). This low viscosity is reduced even further after water is added. ST-504 contains non-volatile materials making up almost 100% of its total weight. Cured ST-504 is very firm and flexible. Its solid is a three dimensional cross-linked molecular structure which is insoluble in water.

PHYSICAL PROPERTIES

Color	Dark brown	
Viscosity	700 cps at 25 C	ASTM D1838
Specific Gravity	1.1 g/cc	9.25 lbs/gal
Flash Point	>220 F	ASTM D-93
Solids Content	>85%	ASTM D2832
Tensile Strength	>250 psi	ASTM 3574
Elongation	>400%	ASTM 3574
Shrinkage	<11%	ASTM D-1042
Vapor Pressure	0.0000002 psi	
Vapor Density	8.5 (Air = 1.0)	
Solubility	Insoluble; Reacts with water	

3601 104th Street Des Moines, Iowa 50322 PHONE 515/251.7770 FAX 515/251.7705
WEB SITE www.strata-tech.com EMAIL Info@strata-tech.com

Set time is the period from first contact of ST-504 with water to the point where the mix becomes too thick for gravity flow. The set time (sometimes called foam time) is influenced primarily by the mix temperature and the ratio of ST-504 to water. Set times are longest at low temperatures and ST-504 ratios, and vary a little with the age of the resin and mineral content of the water. The viscosity of mixed ST-504 is lowest for the first 40% to 50% of the set time and increases rapidly as the mix approaches set.

SET TIME
Seconds at 20 Degrees C

WATER : RESIN	GEL	RISE	TACK FREE
9:1	150	-	-
4:1	95		110
2:1	85	95	100
1:1	95	110	160
1:2	100	120	170
1:3	100	120	180

CLEANUP

ST-504 should not stand in equipment more than 12 hours without precautions because the possibility of moisture contamination is high. Flush equipment with ST-590 purging fluid and ST-522 Cleaner soon after use. The most common solvent for removal of liquid ST-504 is methylene chloride. Check solvents for water content prior to use.

When using solvents during cleanup, extinguish all ignition sources and observe proper precautions for handling such materials. For cleanup of cured ST-504, soak in a 100% solution of ST-522 Veri-Kleen Grout Cleaner using a covered polyethylene container. Grout spills on clothing are permanent, so disposable coveralls are recommended.

HANDLING AND STORAGE

Use reasonable care in handling and storing ST-504. The material is moderately sensitive to high storage temperatures. Under optimum storage of 40 - 60 F in dry conditions, the material should have a useful shelf life of one year. Storage temperature should not exceed 80 F. Once a container has been opened, the life of the material is reduced. Let container stand and adjust to ambient temperature before opening to prevent contamination by condensation. Test a resealed container to assure that moisture contamination has not occurred. Before handling this product, read and understand the Material Safety Data Sheet (MSDS). Instruction in sound safety practices is beyond the scope of this publication.

Direct contact of ST-504 liquid may cause skin and eye irritation. If ST-504 comes in contact with skin, wash with soap and water. For eye contact, flush immediately with water and consult a physician. ST-504 must not be ingested. Before eating, smoking or drinking, remove protective clothing, wash with soap and water, and stand away from the immediate work site. Do not smoke while working with ST-504. If respiratory difficulties occur, seek medical attention. Avoid exposure to vapors created from this product when it is heated. Gloves, goggles, respirator and protective clothing are recommended. Ventilate the work area as a matter of good practice, although hazardous levels of toxic vapors are not generally given off of the bulk product below 90 degrees F. Small amounts of MDI may be present and some users may be sensitive to MDI.

Summary of Handling Precautions:

1. Wear goggles and rubber gloves.
2. Wash any body contact area throughly with water.
3. In case of eye contact, wash immediately with water and seek medical attention.
4. Keep material away from heat and flame.
5. Ventilate and use respirator in hot or closed spaces.

Back to ST-504 Urethane Grout

STATEMENT

Strata Tech believes that the information herein is an accurate description of the general properties and characteristics of the product(s), but the user is responsible for obtaining current information because the body of knowledge on these subjects is constantly enlarged. Information herein is subject to change without notice. Field conditions also vary widely, so users must undertake sufficient verification and testing of the product or process herein to determine performance, safety, usefulness, and suitability for their own particular use.

Strata Tech warrants only that the product will meet Strata Tech's then-current specification. NO WARRANTY OF SUITABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE. Users should not assume that all safety requirements for their particular application(s) have been indicated herein and that other or additional actions and precautions are not necessary. Users are responsible for always reading and understanding the Material Safety Data Sheet, the product technical literature, and the product label before using any product or process mentioned herein and for following the instructions contained therein.

MATERIAL SAFETY DATA SHEET

I

STRATA TECH INC
3601 104th STREET
DES MOINES, IA 50322
INFO PHONE (515) 251-7770

PRODUCT: **ST-504 VARI-LOK**
FAMILY: Isocyanate Prepolymer
REV: May 19, 2014

II HAZARDOUS INGREDIENTS

	CAS	OSHA PEL	ACGIH TLV	CONCEN-TRATION
Diphenylmethane 4,4'-Diisocyanate (MDI)	101-68-8			< 5.0%
Higher Oligomers of MDI	9016-87-9			< 6.0%
Dimethyl Adipate	627-93-0			< 4.0%
Dimethyl Succinate	106-65-0			< 6.0%
Mixed Isomers				
2,4 Toluene Diisocyanate (TDI)	584-84-9			< 1%
2,6- Toluene Diisocyanate (TDI)	91-08-7			
OSHA: . 02 ppm Ceiling				

III PHYSICAL AND CHEMICAL CHARACTERISTICS

Physical State:	Liquid	Density:	9.163 lbs/gal
Boiling Point:	Not Determined	45 lbs net:	18.56 liters
Freezing Point:	Below 32°F (0°C) for MDI	8 lbs net:	3.43 liters
Vapor density:	8.5 (MDI) (Air=1)	Viscosity :	800-900 at 77°F (25°C)
Specific Gravity:	1.1 at 77°F (25°C)	Volatile %:	Negligible
Vapor Pressure:	< 1 x 10-5 mm Hg at 77°F (25°C) for MDI		
Appearance & Odor:	Brown liquid; sweet odor.		
Solubility in Water:	Soluble. Reacts with water to liberate CO_2 gas.		

IV FIRE AND EXPLOSION HAZARD DATA

Flash Point:	>212°F (100°C)
Extinguishing Media:	Dry chemical, carbon dioxide, foam, water spray for large fires.
Fire Fighting:	Wear self-contained positive pressure breathing apparatus and full fire fighting clothing. Vapors & other irritating highly toxic gases may be generated by thermal decomposition or combustion. At temperatures greater than 400°F, isocyanates can polymerize and decompose which can cause pressure build-up in closed containers. Explosive rupture is possible. Use cold water to cool fire-exposed containers.

V REACTIVITY DATA

Stability:	Stable under normal handling conditions.
Incompatibilities:	Water, amines, strong bases, alcohols. Will corrode to copper alloys and aluminum.
Hazardous Polymerization:	May occur; avoid temperature above 400°F (204°C), avoid contact with moisture or other materials which react with isocyanates.
Hazardous Decomposition:	By heat and fire: carbon monoxide, oxides of nitrogen, traces of HCN, MDI and TDI vapors or aerosols.

VI HEALTH HAZARD DATA *EFFECTS OF OVEREXPOSURE AND PRIMARY ROUTES OF ENTRY*

Eyes:	Irritating causing tearing, reddening and swelling. If untreated, corneal damage can occur and injury is slow to heal.
Skin:	May cause some irritation such as reddening, swelling, rash, scaling or blistering.
Ingestion:	Can result in sore throat, abdominal pain, nausea, vomiting and diarrhea.
Inhalation:	Burning in nose, throat and lungs causing breathing difficulty; possible asthma attack, bronchitis, bronchial spasm, pulmonary edema and chemical or hypersensitive pneumonitis.

VII EMERGENCY AND FIRST AID PROCEDURES

Eyes:	Flush open eyes immediately with lukewarm water for 15 minutes; see Physician.
Skin:	Remove contaminated clothing; wash thoroughly, wash with soap & water. Contact physician.
Ingestion:	**Do not induce vomiting**. Give 2 cups of milk or water to drink. Contact Physician immediately.
Inhalation:	Remove to fresh air. Give oxygen if breathing becomes difficult. See Physician.

VIII PRECAUTIONS FOR SAFE HANDLING AND USE

Spills:	Evacuate and ventilate spill area; dike spill; blanket with protein foam; pumped into closed but not sealed containers; absorb isocyanates with sawdust or other absorbent, shovel into suitable unsealed containers, transport outside and treat with large amounts of water, let stand uncovered for 48 hours; decontaminate floor with water.
Disposal:	Incinerate or landfill waste in accordance with Local, State, and Federal regulations.
Handling:	Sensitive to humidity; close container tightly after use. Do not reseal - can be contaminated by moisture. Avoid eye and skin contact. Wash thoroughly after handling. Remove contaminated clothing immediately and launder completely or discard.
Storage:	Stored between 64°F and 86°F. Shelf life is 6 months. If exposed to high heat, 400°F (204°C) container may become pressurized and possibly rupture.

IX CONTROL MEASURES

General:	No special control measures at ambient conditions where work area is adequately ventilated. When airborne concentrations exceed the Federal OSHA exposure standard (0.02 ppm TLV) wear MSHA/NIOSH approved respirator.
Ventilation:	As required to maintain work area below TLV.
Respiratory:	If ventilation is insufficient, wear breathing apparatus or vapor respirator.
Eyes:	Liquid chemical goggles, vapor resistant goggles or full face shield as required.
Skin:	Permeation resistant gloves and clean body-covering clothing.

X SHIPPING AND LABEL DATA

DOT Shipping Name: Plastic Material, Liquid, NOS Hazard Class: N/A
Labels / Placards: ST-504 not regulated as a USDOT hazardous material

IATA	CARGO	PASSENGER
UN #:	N/A	N/A
Limit:	N/A	N/A
Class:	N/A	N/A
Instr:	N/A	N/A

NFPA 704M RATINGS	HMIS RATINGS
0= Insignificant	0= Minimal
1= Slight	1= Slight
2= Moderate	2= Moderate
3= High	3= Serious
4= Extreme	4= Severe

CATEGORY	NFPA	HMIS
Health	3	3
Flammability:	1	1
Reactivity:	1	1
Other:	-	-

AV-330 SAFEGUARD
SAFETY DATA SHEET
Date Issued: 06/01/2015

Section 1: Identification

GHS Product Identifier: AV-330 Safeguard
Classification: Hydrophilic Foam
Product Use: Industrial Use Only

Supplier
Avanti International
1100 Hercules Ave., Suite 320
Houston, TX 77058
Phone: 800.877.2570
Fax: 281.486.7300

24 HR. EMERGENCY TELEPHONE NUMBER
Chemtrec: 800.424.9300

Section 2: Hazards Identification

GHS Classification

Classification	Category	
Skin Sens.	1	Skin sensitization
Resp. Sens.	1A	Respiratory sensitization

GHS Label Elements
Hazard pictograms:

Signal Word:	Warning
Hazards Statements:	
H317	May cause an allergic skin reaction.
H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.
Precautionary Statements:	**General:**
P201	Obtain special instructions before use.
P202	Do not handle until all safety precautions have been read and understood.
P210	Keep away from heat, hot surfaces, open flames, sparks. - No smoking.
P233	Keep container tightly closed.
P260	Do not breathe fume, mist, spray, vapors.
P264	Wash thoroughly after handling.
P302 + P352	IF ON SKIN: Wash with plenty of soap and water.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water.
P304 + P340	IF INHALED: Remove person to fresh air and keep comfortable for breathing.
P305 + P351 + P338	IF in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313	IF exposed or concerned: Get medical advice/attention.
P314	Get medical advice and attention if you feel unwell.
P332 + P313	If skin irritation occurs: Get medical advice/attention.
P337 + P313	If eye irritation persists: Get medical advice/attention.
P342 + P311	If experiencing respiratory symptoms: Call a poison center or doctor.
P361	Remove/Take off immediately all contaminated clothing.
P362 + P364	Take off contaminated clothing and wash it before reuse.
P363	Wash contaminated clothing before reuse.
P370 + P378	In case of fire: Use media for extinction.
P403 + P235	Store in a well-ventilated place. Keep cool.

P405	Store locked up.
P501	Dispose of contents/container according to local, regional, national, and international regulations.

Other hazards not contributing to the classification:
Exposure may aggravate those with pre-existing eye, skin, or respiratory conditions.

Unknown Acute Toxicity (GHS-US):
No data available.

Section 3: Composition/Information on Ingredients

Hazardous Components

Weight %	Components	CAS-No./EINCS	Classification
80-85%	Oxirane, methyl-, polymer with oxirane, ether with 1,2,3-propanetriol (3:1), polymer with 1,1'-methylenebis[4-isocyanatobenzene]	(CAS #) 59675-67-1	Resp. Sens. 1, H334 Skin Sens. 1, H317
15-20%	Diethylene Clycol Ether Acetate	(CAS #) 112-15-2 (EINCS) 203-940-1	Skin Irrit. 3; H316 Eye Irrit. 2A; H319
>1%	4,4'-Methylenebis(phenyl isocyanate)	(CAS #) 101-68-8 (EINCS) 202-966-0	Acute Tox 4; H332 Skin Irrit. 2; H315 Eye Irrit. 2A; H319 Resp. Sens. 1; H334 Skin Sense. 1; H317 Carc. 2; H351 STOT SE 3; H335 STOT RE 2; H373

Full text of H-phrases: See Section 16

Section 4: First-Aid Measures

Description of First-Aid Measures

First-aid Measures General
Never give anything by mouth to an unconscious person. If you feel unwell, seek medical advice (show the label if possible).

First-aid Measures After Inhalation
Remove to fresh air and keep at rest in a position comfortable for breathing. Obtain medical attention if breathing difficulty persists.

First-aid Measures After Skin Contact
Rinse immediately with plenty of water. Obtain medical attention if irritation develops or persists.

First-aid Measures After Eye Contact
Rinse cautiously with water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Obtain medical attention.

First-aid Measures After Ingestion
Do NOT induce vomiting. Rinse mouth. Immediately call a Poison Center or doctor/physician.
Most Important Symptoms and Effects, Both Acute and Delayed
Symptoms/Injuries: May cause an allergic skin reaction. Inhalation may cause allergic respiratory reaction with asthma-like symptoms and difficulty breathing.
Symptoms/Injuries After Inhalation: May cause allergy or asthma symptoms or breathing difficulties if inhaled.
Symptoms/Injuries After Skin Contact: May cause an allergic skin reaction.
Symptoms/Injuries After Eye Contact: May cause eye irritation.
Symptoms/Injuries After ingestion: Ingestion is likely to be harmful or have adverse effects.
Chromic Symptoms: Exposure may produce an allergic reaction.
Chronic Symptoms:

Exposure may produce an allergic reaction.

Indication of Any Immediate Medical Attention and Special Treatment Needed. If exposed or concerned, get medical advice and attention.

Section 5: Fire-Fighting Measures

Suitable Extinguishing Media:	Use dry chemical, water spray or other extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media:	Do not use heavy water stream. Use of heavy stream of water may spread fire.
Special Hazards Arising from Substance or Mixture	**Fire Hazard:** Not considered flammable but may burn at high temperatures. **Reactivity:** Hazardous reactions will not occur under normal conditions. **Explosion Hazard:** Product is not explosive. DO NOT weld, burn or cut empty containers.
Fire-fighting Procedure	Exercise caution when fighting any chemical fire. Fire fighters should wear self-contained breathing apparatus to protect against inhalation of cyanates vapors and other decomposition/combustion products. Do not release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full face piece operated in pressure-demand or positive-pressure mode.
Other information	Refer to Section 9 for flammability properties.

Section 6: Accidental Release Measures

Personal Precautions, Protective Equipment and Emergency Procedures

General Measures

Do not get in eyes, on skin, or on clothing. Do not breathe vapor or mist.

For Non-emergency Personnel

Protective Equipment: Use appropriate personal protection equipment (PPE).

Emergency Procedures: Evacuate unnecessary personnel.

For Emergency Responders

Protective Equipment: Equip cleanup crew with proper protection.

Emergency Procedures: Stop leak if safe to do so. Eliminate ignition sources. Ventilate area.

Environmental Precautions

Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters.

Methods and Material for Containment and Cleaning-Up

For Containment: Contain any spills with dikes or absorbents to prevent migration and entry into sewers or streams.

For Cleaning Up: Clear up spills immediately and dispose of waste safely. Spills should be contained with mechanical barriers. Transfer spilled material to a suitable container for disposal. Contact competent authorities after a spill.

Reference to Other Sections

See Heading 8. Exposure controls and personal protection

Section 7: Handling and Storage

Precautions for Safe Handling

Keep away from sources of ignition - No smoking. Keep away from heat & open flame. Avoid all eye & skin contact & do not breathe vapor or mist. Always wash hands after handling. Do not eat, drink or smoke when using this product. Ensure there is adequate ventilation. Wear recommended personal protective equipment. Take precautionary measures against static discharge. Use grounded electrical/mechanical equipment.

Hygiene Measures

Handle in accordance with good industrial hygiene and safety procedures. Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work.

Conditions for Safe Storage (Including Any Incompatibilities)

Technical Measures: Comply with applicable regulations.
Storage Conditions: Store in a dry, cool and well-ventilated place. Keep container closed when not in use.
Keep/Store away from direct sunlight, extremely high or low temperatures and incompatible materials. Shelf life is 6 months in unopened containers.
Incompatible Products: Isocyanates react slowly with water, alcohols, amines, acids and bases.

Section 8: Exposure Controls/Personal Protection

Control Parameters

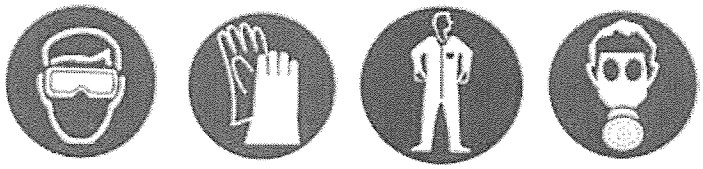
For substances listed in section 3 that are not listed here, there are no established exposure limits from the manufacturer, supplier, importer, or the appropriate advisory agency including: ACGIH (TLV), NIOSH (REL), or OSHA (PEL).

4,4'-methylenediphenyl diisocyanate (4,4' MDI) (101-68-8)

ACGIH	TLV (ppm)	0.0050 ppm
OSHA	PEL (ppm)	0.02 ppm
NIOSH	TWA (ppm)	0.0050 ppm

Exposure Controls

Appropriate Engineering Controls: Ensure adequate ventilation, especially in confined areas. Emergency eye wash fountains and safety showers should be available in immediate vicinity of any potential exposure. Ensure all national/local regulations are observed.
Personal Protective Equipment: Protective goggles, gloves, protective clothing. If insufficient ventilation: wear respiratory protection



Personal Protective Equipment

Respiratory Protection:

Follow OSHA respirator regulation 29 CFR 1910.134 and European Standards EN 141, 143 and 371; wear a MSHA/NIOSH or European Standards EN 141, 143 and 371 approved respirators when needed.

Skin and Body Protection:

Wear suitable protective clothing. Wear chemically resistant protective gloves.

Eye Protection:

Chemical goggles or safety glasses.

Environmental Exposure Controls:

Do not allow the product to be released into the environment.

Consumer Exposure Controls:

Do not eat, drink or smoke during use.

Section 9: Physical and Chemical Properties

Appearance: Transparent yellow liquid
Odor: Slightly musty odor
Odor Threshold: 0.39 ppm (MDI)
pH: No data available
Freezing Point: No data available
Boiling Point: 245°C (450°F) @ 750 mm Hg for MDI

Flashpoint: 116.67°C (242°F) CC
Evaporation Rate: No data available (butylacetate=1)
Flammability: No data available
Lower Explosion Limits: Not determined
Upper explosion limits: Not determined
Vapor Pressure: Less than .010 mm Hg @ 68°F
Relative Vapor Density at 20°C: 3.66 (air=1)
Relative Density: No data available.
Solubility in Water: Completely soluble
Partition Coefficient n-octanol/water: No data available
Auto-ignition Temperature: No data available
Decomposition Temperature: No data available
Viscosity: 850 CPS @ 77°F (25°C)
Oxidizing Properties: No data available
Specific Gravity: 1.09 (water = 1)
Explosive Properties: Product is not explosive; however, formation of explosive air vapor mixture is possible.

Section 10: Stability and Reactivity

Reactivity
Hazardous reactions will not occur under normal conditions.

Chemical stability
Stable under recommended handling and storage conditions (see Section 7).

Possibility of hazardous reactions
May occur, contact with moisture and other materials, which react with isocyanates, or temperatures about 400° F (204° C), may cause some polymerization.

Conditions to avoid
Direct sunlight. Extremely high or low temperatures. Ignition sources. Incompatible materials.

Incompatible materials
Water, amines, strong bases, and alcohols will cause some corrosion to copper alloys and aluminum.

Hazardous decomposition products
Can produce carbon dioxide, carbon monoxide.

Section 11: Toxicological Information

Acute Toxicity/Effects
Not Classified

Diethylene Clycol Ether Acetate (112-15-2)	
LD50 Oral Rat (mg/kg)	11,200 mg/kg
LD50 Dermal Rabbit	15,281 mg/kg
4,4'-Methylenebis(phenyl isocyanate) (101-68-8)	
LD50 Oral Rat	9,200 mg/kg
LD50 Inhalation Rat	2.24 mg/l (1 hr)
Skin Corrosion/Irritation	May cause minor skin irritation
Serious Eye Damage/Irritation	May cause mild eye irritation
Respiratory or Skin Sensitization	May cause allergy or asthma symptoms or breathing difficulties if inhaled. May cause an allergic skin reaction.
Germ Cell Mutagenicity	Not classified

Carcinogenicity	Not classified
Reproductive Toxicity	Not classified
STOT (Single Exposure)	Not classified
STOT (Repeated Exposure)	Not classified
Aspiration Hazard	Not classified

Section 12: Ecological Information

Toxicity

4,4'-Methylenebis(phenyl isocyanate) (101-68-8)	
EC50 Daphnia 1	0.35 mg/l (Exposure time: 24 h - Species: Daphnia magna [Static])

Persistence and Degradability:
No additional information available.

Bioaccumulative Potential:
No additional information available.

Mobility in Soil:
No additional information available.

Other Adverse Effects:
Avoid release to the environment.

Section 13: Disposal Considerations

Waste Disposal Recommendations:
Dispose of waste material in accordance with all local, regional, national, & international regulations.

Sewage Waste Recommendations:
Do not dispose of waste into sewer.

Section 14: Transport Information

DOT (Department of Transportation)
Proper Shipping Name: Liquid Resin (Non-Regulated)
Hazard Class: Non-regulated
UN Number: Not applicable
Packing Group: None
Label: Not applicable
Placard: Not applicable
NMFC (National Motor Freight Carriers)
Freight Class: 55
IMO / IMDG CODE (OCEAN) HAZARD CLASS DIVISION NUMBER: Non-regulated/Not dangerous goods
ICAO / IATA (AIR) HAZARD CLASS DIVISION NUMBER: Non-regulated/Not dangerous goods

Section 15: Regulatory Information

US Federal Regulations

SARA Section 311/312 Hazard Classes: Acute Health Hazard

SARA Section 313 Components
Diethylene Clycol Ether Acetate (112-15-2)

4,4'-Methylenebis(phenyl isocyanate) (101-68-8)

Oxirane, methyl-, polymer with oxirane, ether with 1,2,3-propanetriol (3:1), polymer with 1,1'-methylenebis[4-isocyanatobenzene] (59675-67-1)- Listed on the United States TSCA (Toxic Substances Control Act) inventory

US State Regulations

Diethylene Clycol Ether Acetate (112-15-2)
U.S. - Pennsylvania - RTK (Right to Know) List
U.S. – New Jersey - RTK (Right to Know) List

4,4'-Methylenebis(phenyl isocyanate) (101-68-8)
U.S. - Pennsylvania - RTK (Right to Know) List
U.S. – New Jersey - RTK (Right to Know) List
U.S. – Massachusetts – RTK (Right to Know) List

Section 16: Other Information

Skin Sens. A	H317	Skin sensitization Category 1
Resp. Sens. 1	H334	May cause allergy or asthma symptoms or breathing difficulties if inhaled.

NFPA 704M ratings:	**Health** 2	**Flammability** 1	**Reactivity** 1	**Other**
HMIS ratings: **0-Insignificate** **1-Slight** **2-Moderate** **3-High** **4-Extreme**	**Health** 2	**Flammability** 1	**Physical Hazard** 1	**Personal Protection** G

The information provided in this Safety Data Sheet is correct to the best of Avanti International's knowledge, information and belief at the date of this publication. The information given is designed only as guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any other process, unless specified in the text. AVANTI INTERNATIONAL MAKES NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR COURSE OF PERFORMANCE OR USAGE OF TRADE. Given the variety of factors that can affect the use and application of this product, some of which are uniquely within the user's knowledge and control, it is essential that the user evaluate the product to determine whether it is fit for a particular purpose and suitable for user's method of use or application. Each user is also responsible for evaluating the conditions of use and designing the appropriate protective mechanisms to prevent employee exposures, property damage, or release to the environment. Avanti International assumes no responsibility for injury to the recipient or third persons or for any damage to any property resulting from misuse of the product.

AVANTI
Stop leaks. Stabilize soil.
Control groundwater. Permanently.

Rev03.2014

TECHNICAL DATA SHEET

AV-330 SAFEGUARD

HYDROPHILIC POLYURETHANE FOAM

DESCRIPTION

AV-330 Safeguard is a 100% MDI-based, single component, mid-range viscosity, moisture activated polyurethane injection resin. This high quality water-activated resin is designed for sealing active leaks in below grade structures. It is a mid-range viscosity grout that permeates well in various cracks and joints, but offers added safety in confined spaces or where there is poor ventilation. It cures to become a resilient and flexible, yet tough, closed-cell foam. Certified for use in potable water.

APPLICATION

- Areas with poor ventilation or confined spaces (utility vaults, sub-grade pump houses, lift stations, mines, tunnels, and basements)
- Medium cracks or joints in concrete structures
- Great for manholes and pipe penetrations

FEATURES AND BENEFITS

- ANSI/NSF 61 Potable Water Systems UL Certified
- 100% MDI-based
- Mid-range viscosity penetrates well
- Expands 400% – 600%
- Solvent-free system and non-corrosive
- Forms a resilient, flexible foam with superb adhesive properties

GROUTING TECHNIQUES

- Expanded Gasket Placement Technique (EGP)
- Variable Pressure Application Technique (V-PAT) – Crack Injection

HOW IT WORKS

AV-330 Safeguard can be applied via two techniques: EGP or V-PAT. The resin reacts to moisture to form a resilient, flexible seal accomplished by three mechanisms: the resin seeks out water in the space and *adheres* to the surface, then begins to expand forming a tight *compressive* seal while the network of compressed grout material within all the cracks forms a *mechanical* lock.

RATIOS

Preferred ratio is 1:1 (water to resin), however no pre-mixing is required. Pumped as a single component.

PACKAGING

Product packaged by weight based on specific gravity.

- Drum = Net Wt. 465 lbs. / Volume 48.5 – 49.8 gal.
- Pail = Net Wt. 44 lbs. / Volume 4.58 – 4.7 gal.
- Gallon = Net Wt. 8 lbs. / Volume ~1 gal.

SHIPPING

- Motor Class 55
- Non-Hazardous
- Air freight available

PROPERTIES*

UNCURED	
Appearance:	Pale yellow liquid
Viscosity:	350 – 750 cP @ 72°F (22°C)
Flash Point:	>200°F (>93°C)
Specific Gravity:	1.12 @ 72°F (22°C) ± 3%
Weight:	9.32 lb/gal ± 3% (1.117 kg/L ± 3%)
CURED	
Appearance:	Milky colored flexible foam
Tensile Strength:	TBD
Elongation:	TBD

*Laboratory Results

PERFORMANCE

Flush equipment with **AV-208** before and after use to remove moisture and clean equipment. For best results, use between 60°F – 90°F (16°C – 32°C). Performance will be influenced by site conditions. If site temperatures are low, use a heat source to warm to ~72°F (22°C) and apply. Do not use open flame as a heat source.

CLEANING PRODUCTS

- **AV-208** Acetone, Technical Grade (CAS# 67-64-1) – removes moisture from equipment (see Performance section).
- **AV-284** Pump Wash (Proprietary Blend) – removes uncured resin from pump and hose, leave in pump for storage.
- **AV-222** Cleaner (Proprietary Blend) – removes cured resin from equipment.

STORAGE

Store in temperatures within or near 60°F – 90°F (16°C – 32°C) in a dry atmosphere.

SAFETY

Always use OSHA-approved personal protective equipment (PPE). Refer to the MSDS for complete safety precautions. The MSDS is available by request or via download at www.AvantiGrout.com.

NOTICE

The data, information and statements contained herein are believed to be reliable, but are not construed as a warranty or representation for which Avanti International assumes any legal responsibility. Since field conditions vary widely, users must undertake sufficient verification and testing to determine the suitability of any product or process mentioned in this or any other written material from Avanti for their own particular use. NO WARRANTY OF SUITABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE. In no case shall Avanti International be liable for consequential, special, or indirect damages resulting from the use or handling of this product.

CLASSIFIED UL WATER QUALITY

DRINKING WATER SYSTEM COMPONENT
ANSI/NSF 61
88NN

Certificate of Compliance

Certificate Number 010806 - MH20894
Report Reference MH20894, April 23, 2003
Issue Date 2006 August 1

Underwriters Laboratories Inc.®

Issued to: Avanti International
822 Bay Star Blvd
Webster, TX 77598

This is to certify that representative samples of AV-330 Safeguard

Water Contact Temperature
23° C

Surface Area to Volume Ratio
1sq cm/L

Have been investigated by Underwriters Laboratories Inc.® in accordance with the Standard(s) indicated on this Certificate.

Standard(s) for Safety: ANSI/NSF Standard 61 Drinking Water Systems Components

Additional Information: Factory Location: Webster, TX

Only those products bearing the UL Classification Mark should be considered as being covered by UL's Classification and Follow-Up Service.

The UL Classification Mark includes: UL in a circle symbol: with the word "CLASSIFIED" (as shown); a control number (may be alphanumeric) assigned by UL; a statement to indicate the extent of UL's evaluation of the product; and, the product category name (product identity) as indicated in the appropriate UL Directory.

Look for the UL Classification Mark on the product

Issued by: Willard Casper
Willard Casper
Underwriters Laboratories Inc.

Reviewed by: Douglas Frederick
Douglas Frederick
Underwriters Laboratories Inc.

de neef®

Washing Agent
Non-Flammable Solvent

Product Description

Washing Agent is a non-flammable solvent mixture for cleaning polyurethane grout pumps and equipment. **Washing Agent** is composed of a mixture of organic solvents with high dissolving properties for liquid polyurethane products.

Product Advantages

- Non-flammable
- Anhydrous

Applications

Flushing out and cleaning pumps and lines used to inject polyurethane grouts.

Properties

Physical Properties	
Specific Density	Approx 9.6 lbs/gal
Appearance	Clear Liquid
Flashpoint	225°F

Note: The data shown above reflects typical results based on laboratory testing under controlled conditions. Reasonable variations from the data shown above may result.

Packaging & Handling

5 Gallon metal pails, closed head with a flex spout.

Health and Safety

Avoid repeated inhalation of large quantities: If necessary, wear a mask (for organic vapors). Do not spray if sufficient ventilation is unavailable. Observe all safety rules as noted on the label. Always use protective clothing, gloves and goggles consistent with OSHA regulations during use. Avoid eye and skin contact. Do not ingest. Refer to Material Safety Data Sheet for detailed safety precautions.

In the event of an EMERGENCY call: CHEMTREC 800-424-9300.

Limitations

Limited effect on cured polyurethane resin.

Pump Start Up

For most pumps, there are two separate lines.

Main pickup line (large line)

Prime line (small line)

The main pickup line sucks the material into the pump. The prime line is the smaller tube running alongside the main line. The objective is to NOT contaminate the DeNeef Washing Agent with either water or urethane grout.

You will need two buckets:

One empty bucket that will be the trash bucket.

One bucket filled with 3/4 gallon DeNeef Washing Agent.

1. Separate the main pickup line from the prime line.

2. Place the main pickup line into the Washing Agent.

3. Place the prime line into the trash bucket.

4. Start the pump.

5. Turn the prime switch to prime.

6. Let the prime line run into the trash bucket for 5 - 10 seconds. While the Washing Agent is still running, move the prime line over into the Washing Agent bucket. Let it run for about 1 minute. A steady flow of Washing Agent should be running out of the prime line.

7. Turn prime switch off. Pump should now be ready with DeNeef Washing Agent in the injection hose.

8. Point the grease gun into the trash bucket. Pull the trigger and let it run for 5 - 10 seconds.Release the trigger and point the gun into the Washing Agent bucket. Pull the trigger and let it run for 1 minute.

Grouting

9. Pour Urethane grout from original container into an open top bucket. Add the catalyst and stir it into the grout slowly for 2 - 3 minutes.

10. Place the main pickup line into the urethane grout.

11. Place the prime line into the trash bucket.

12. Turn on the prime switch to prime. Let it run until the Washing Agent runs out and urethane grout starts running through the prime line. Turn prime switch off.

13. Place the prime line into the urethane grout.

14. Point the gun into the trash bucket and pull the trigger. Let it run until clear Washing Agent turns amber. You are now ready to grout.

Pump Shut Down

15. Repeat this process using the Washing Agent.

16. Clean the prime line for 3 - 4 minutes.

17. Switch to the main pickup line.

18. Run the remaining urethane grout into the trash bucket.

19. When it runs with Washing Agent, recirculate Washing Agent for 3 - 4 minutes

www.deneef.com

Technical Service 1-800-732-0166

DN-049 Printed in U.S.A. 12/11 FA/PDF

GRACE

de neef Material Safety Data Sheet

I. PRODUCT IDENTIFICATION & USE

Commercial Name: **KF-500**

W.R.Grace & Co.-Conn.
62 Whittemore Avenue
Cambridge, MA 02140

Grace Canada, Inc.
294 Clements Road West
Ajax, Ontario L1S 3C6

In Case of Emergency Call:

In USA: (617) 876-1400 In Canada: (905) 683-8561

II. INGREDIENTS

Ingredients:	%	CAS Number	LD_{50} of Ingredient
Potassium Ferricyanide $K_3Fe(CN)_6$		13746-66-2	TSDS: oral rat LDL_o 1600 mg/Kg (low toxicity)

This chemical is of low toxicity since the CN is tightly bound, and it is in no sense the powerful poison that the simple cyanide salts are.

III. PHYSICAL DATA

Physical State:	Crystal or Powder
Odor & Appearance:	Bright red, lustrous crystals or powder
Odor Threshold (ppm):	None established (low toxicity)
Boiling Point (°C):	N/Ap
Freezing Point (°C):	N/Ap
Vapor Pressure:	N/Ap
Vapor Density:	N/Ap
Evaporation Rate:	N/Ap
pH:	N/Ap
Specific Gravity (H_2O=1):	1.843 @ 17°C
Coeff. Water/Oil Dist:	N/Ap

N/Av=Not Available *N/Ap=Not Applicable* *ca.=Approximate*

IV. FIRE & EXPLOSION HAZARD DATA

☐ Yes ■ No

If Yes, under which conditions?

Means of extinction:	Water: use self-contained breathing suits
Flashpoint & Method:	N/Ap
Upper flammability limit:	N/Ap
Lower flammability limit:	N/Ap
Autoignition temperature:	N/Ap
Hazardous combustion products:	Dangerous when heated to decomposition or by contact with acid or acid fumes; will emit toxic cyanide fumes
Sensitivity to impact:	None
Sensitivity to static discharge:	None

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V. REACTIVITY DATA

■ Stable ☐ Unstable

If unstable, under which conditions?

Incompatibility with other substances:	■ Yes	Avoid all contact with acid or acid fumes; combustible organics and reducing agents
Reactivity, and under what conditions:	■ Yes	Avoid sunlight, heat, acids and acid fumes.
Hazardous decomposition products:	■ Yes	Contact with acid or acid fumes may emit highly toxic fumes of cyanide.

* Hazardous polymerization Will Not occur.

VI. TOXICOLOGICAL PROPERTIES

■ Skin Contact ■ Eye Contact ■ Inhalation ■ Ingestion ☐ Skin Absorption

Effects of acute/chronic exposure to product:	Non-volatile cyanide salts appear to be relatively non -toxic so long as they are not ingested and care is taken to prevent formation of hydrocyanic acid by contact with acids or acid fumes.
Exposure limits:	None established; of low viscosity
Irritancy of product:	Yes
Sensitization to product:	Yes
Carcinogenicity:	No
Teratogencity:	No
Reproductive toxicity:	No
Mutagenicity:	No
Synergistic products:	No

VII. PREVENTATIVE MEASURES

Personal protective equipment:

Gloves:	Dry rubber gloves
Respirator (specify):	For large volume usage, dust type breathing mask or dust proof head gear and clothing
Eye (specify):	Safety goggles or glasses
Footwear (specify):	Standard footwear for industrial use
Clothing (specify):	Normal work clothes
Others (specify):	Good personal hygiene
Engineering controls:	Local exhaust generally not needed; mechanical exhaust generally not needed. Avoid acid exhausts.
Leak & spill procedure:	Sweep up all material and recover as much as possible, Do Not deposit sweepings in acid storage areas.
Waste disposal:	Do Not dump into river, streams or stream beds. Waste disposal of potassium ferricyanide depends to a great extent upon local requirements. Be sure to follow all federal, state and local regulations regarding health and pollution.
Handling procedures & equipment:	Keep containers tightly closed and plainly labeled. Clean any spills promptly.
Storage requirements:	Store away from eating areas. Do not store near heat or open flame. Do not store in contact with acid or acid fumes. Contact with acid fumes may emit highly toxic cyanide fumes; especially under disaster conditions.
Special shipping instructions:	

VIII. FIRST AID MEASURES

Specific Measures:

EYES:	Flush with water for 15 minutes - seek medical attention.
SKIN:	Wash with soap and water - no not use acid type hand cleaners.
INGESTION:	Induce vomiting with soap; Do not use vinegar. Seek immediate medical attention.
INHALATION:	Remove to fresh air.

SECTION IX: OTHER INFORMATION

NFPA, NPCA-HMIS

NPCA-HMIS Rating

Health:	1
Flammability:	0
Reactivity:	0

IX. PREPARATION DATE OF MSDS

Prepared by:	Technical Service Dept.
Date:	February 7, 2006
Phone number:	713-896-0123

www.deneef.com

Appendix C:

Additional Photos

Appendix C
Additional Photos

Figure 1: ST-504 Test 1 after Injection

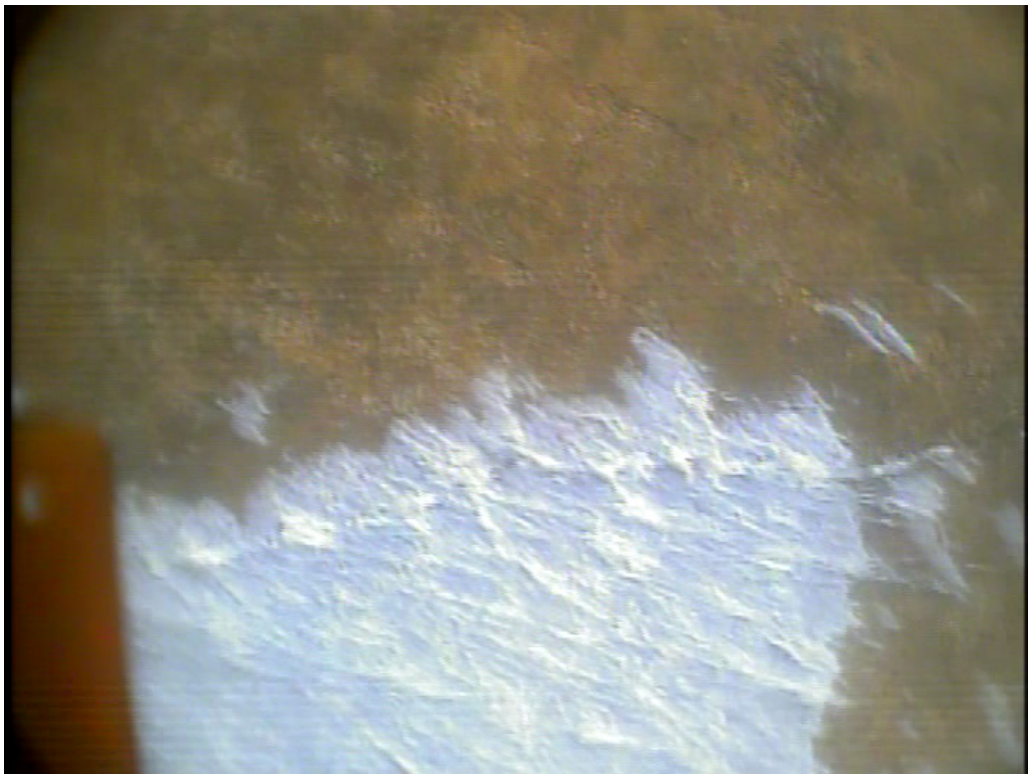


Figure 2: ST-504 Test 1 after Injection

Appendix C
Additional Photos

Figure 3: ST-504 Test 2 prior to Injection

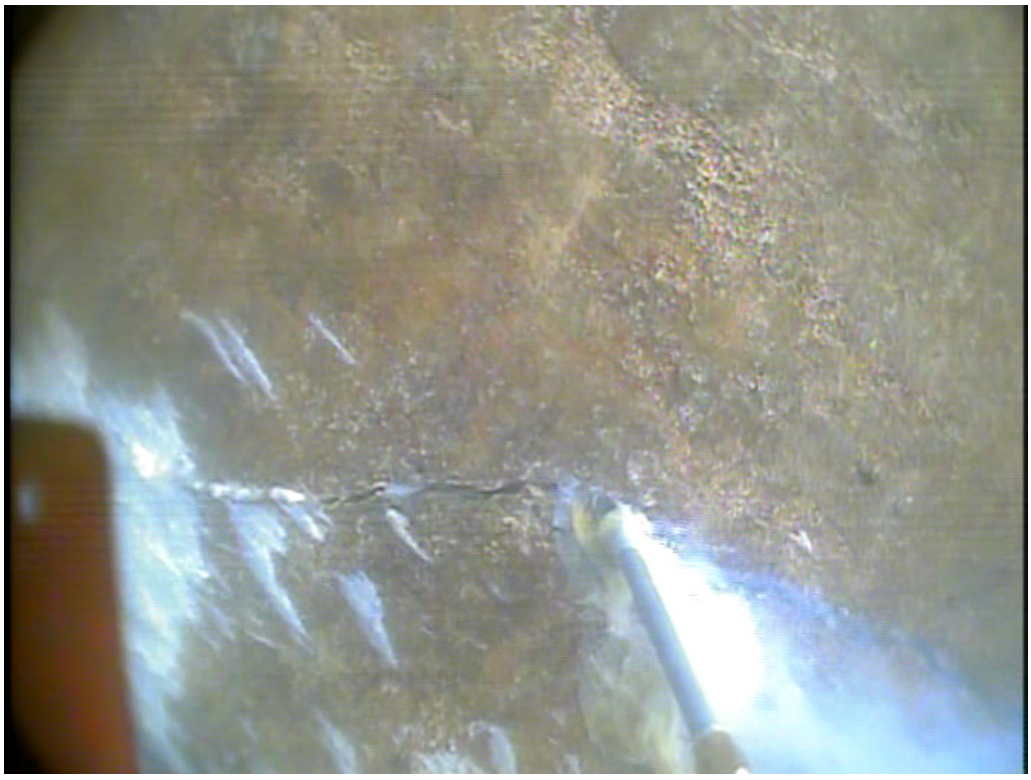


Figure 4: ST-504 Test 2

Appendix C
Additional Photos

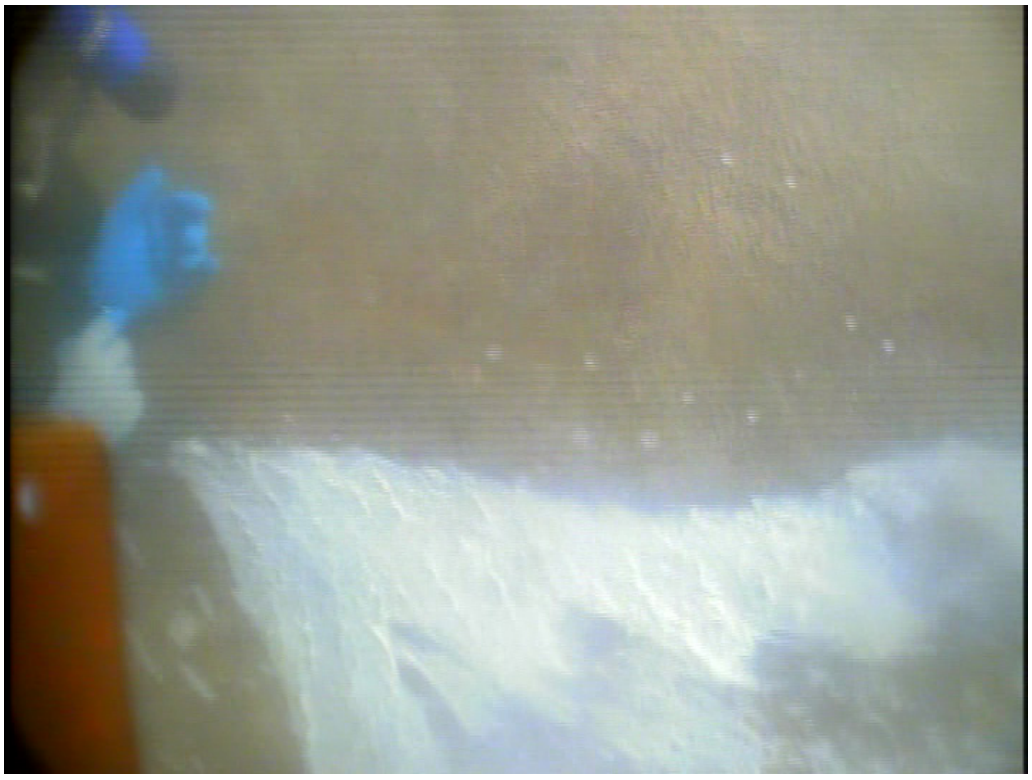


Figure 5: ST-504 Test 2 after Injection

Figure 6: ST-504 Test 3 prior to Injection

Appendix C
Additional Photos

Figure 7: ST-504 Test 3

Figure 8: ST-504 Test 3 after Injection

Appendix C
Additional Photos

Figure 9: ST-504 Test 4 prior to Injection

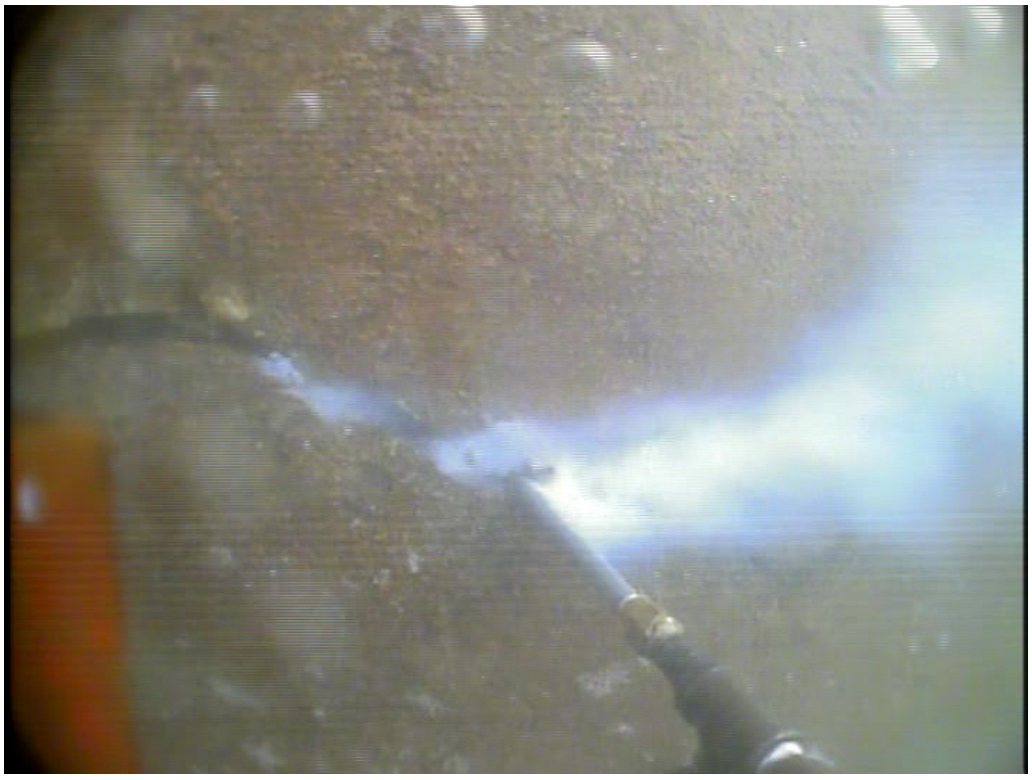


Figure 10: ST-504 Test 4

Appendix C
Additional Photos

Figure 11: ST-504 Test 5 prior to Injection

Figure 12: ST-504 Test 5

Appendix C
Additional Photos

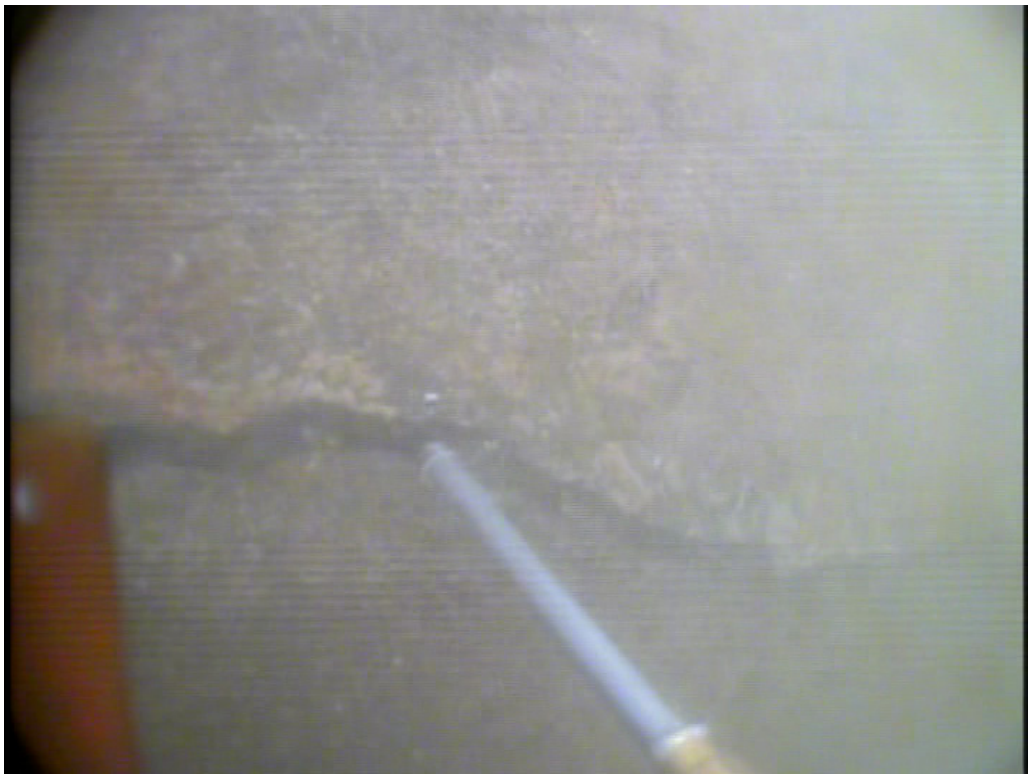


Figure 13: ST-504 Test 6 prior to Injection

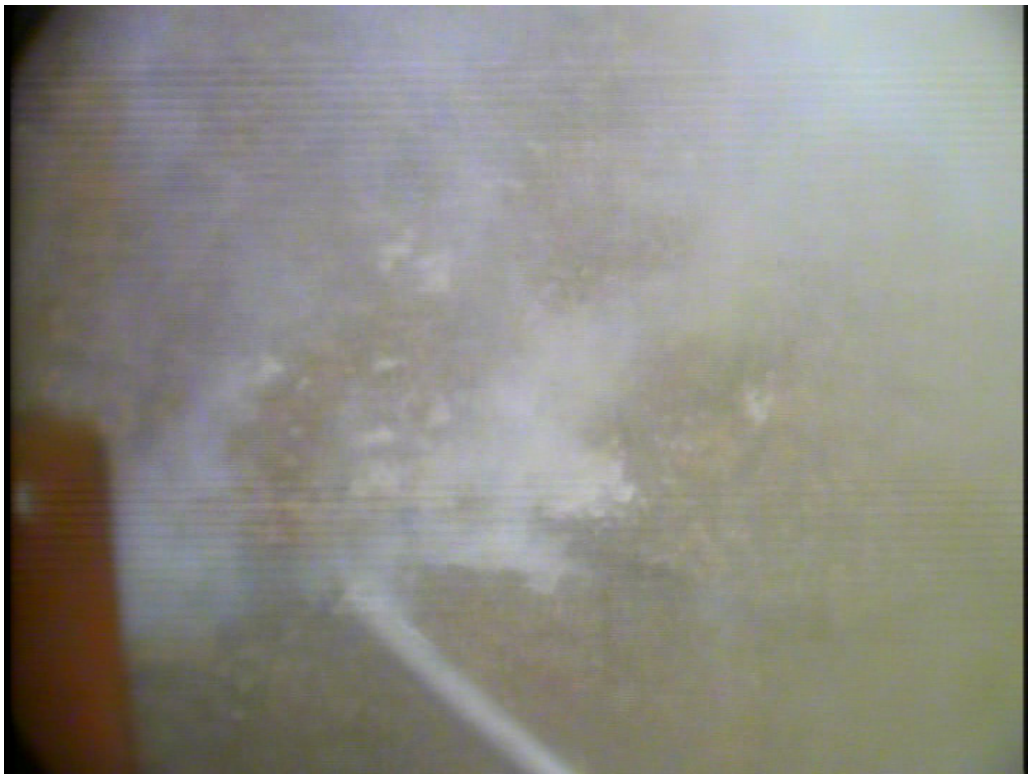


Figure 14: ST-504 Test 6

Appendix C
Additional Photos

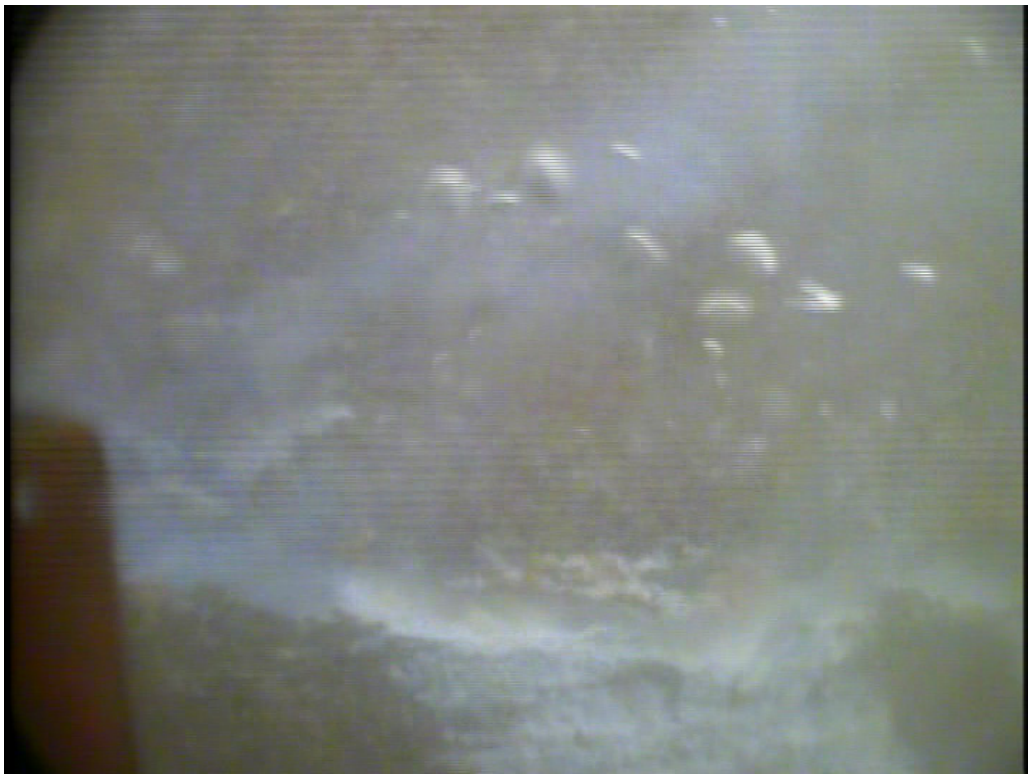


Figure 15: ST-504 Test 6 after Injection

Figure 16: ST-504 Test 7 prior to Injection

Appendix C
Additional Photos

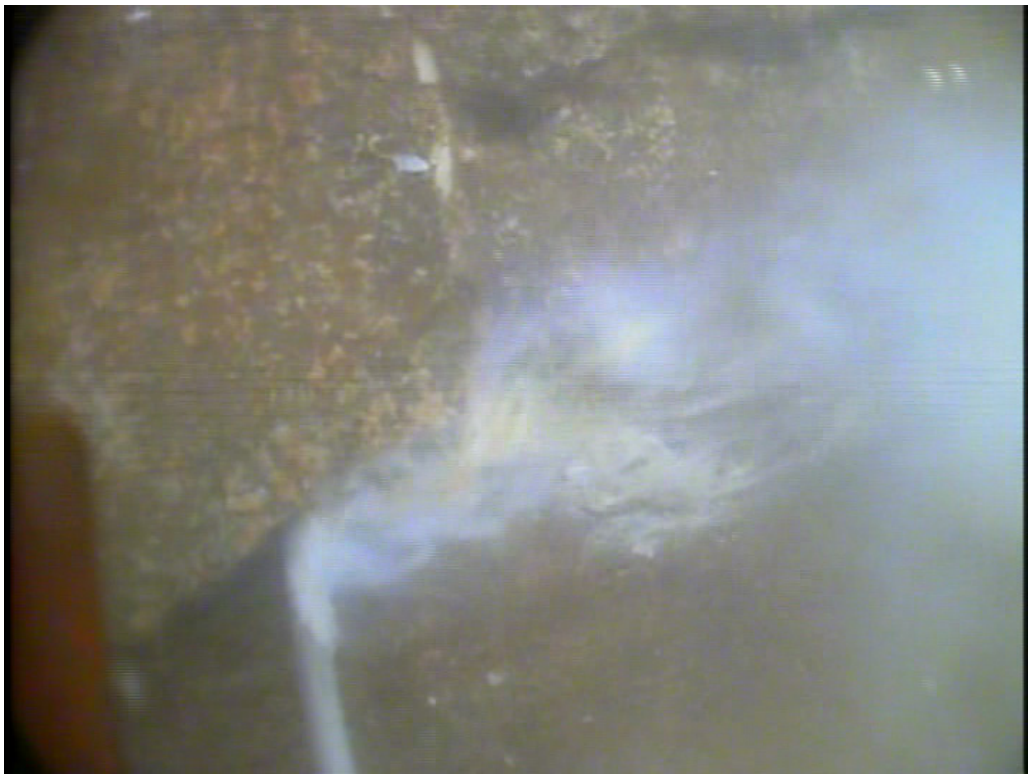


Figure 17: ST-504 Test 7

Appendix C
Additional Photos

Figure 18: AV-330 Test 1 prior to Injection

Figure 19: AV-330 Test 1

Appendix C
Additional Photos

Figure 20: AV-330 Test 1 after Injection

Figure 21: AV-330 Test 2 prior to Injection

Appendix C
Additional Photos

Figure 22: AV-330 Test 2

Figure 23: AV-330 Test 2 after Injection

Appendix C
Additional Photos

Figure 24: AV-330 Test 3 prior to Injection

Figure 25: AV-330 Test 3

Appendix C
Additional Photos

Figure 26: AV-330 Test 3 after Injection

Figure 27: AV-330 Test 4 prior to Injection

Appendix C
Additional Photos

Figure 28: AV-330 Test 4

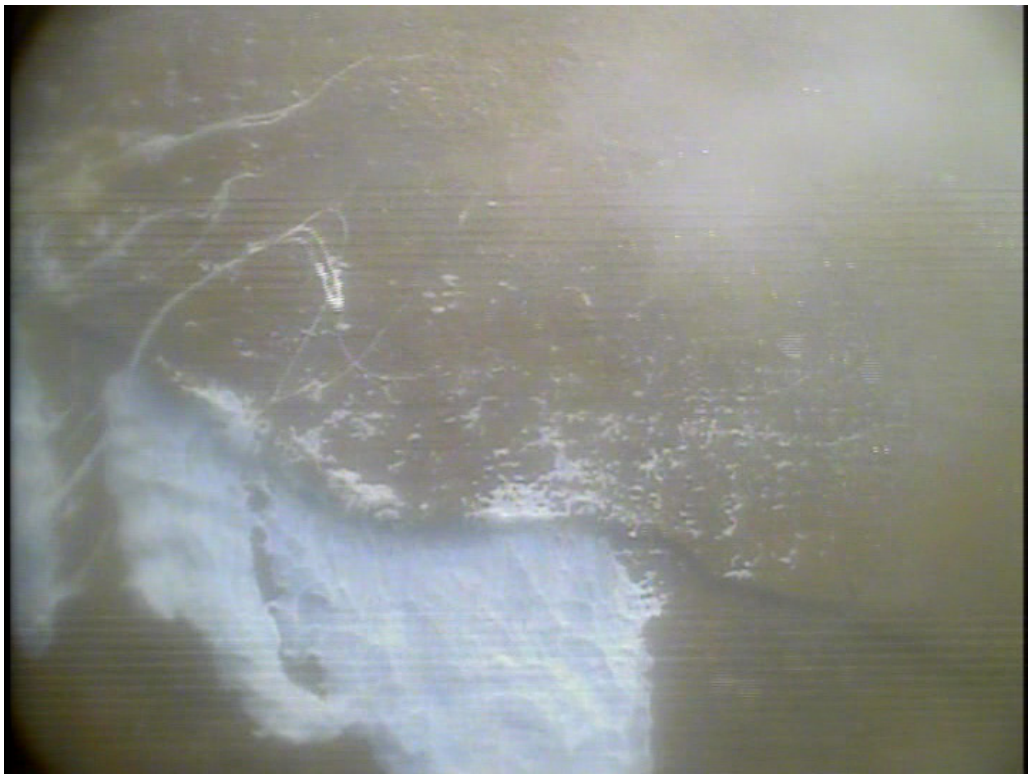


Figure 29: AV-330 Test 4 after Injection

Appendix C
Additional Photos

Figure 30: AV-330 Test 5 prior to injection

Figure 31: AV-330 Test 5

Appendix C
Additional Photos

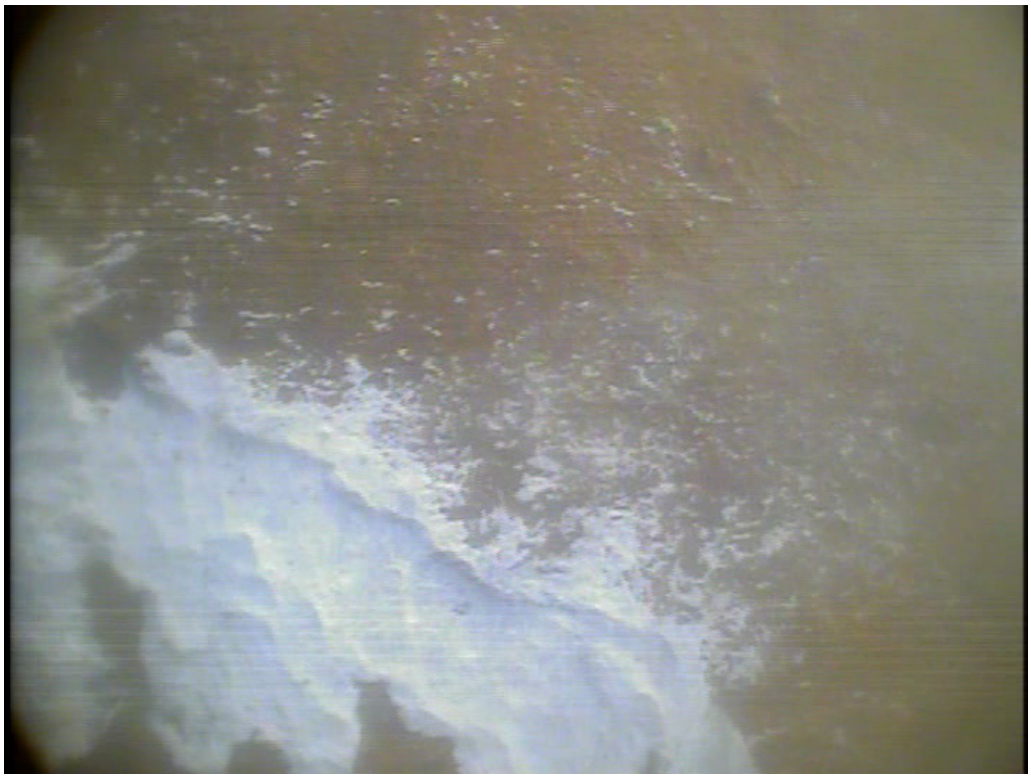


Figure 32: AV-330 Test 5 after Injection

Appendix D:

Existing Canal Drawings

Appendix D
Existing Canal Drawings

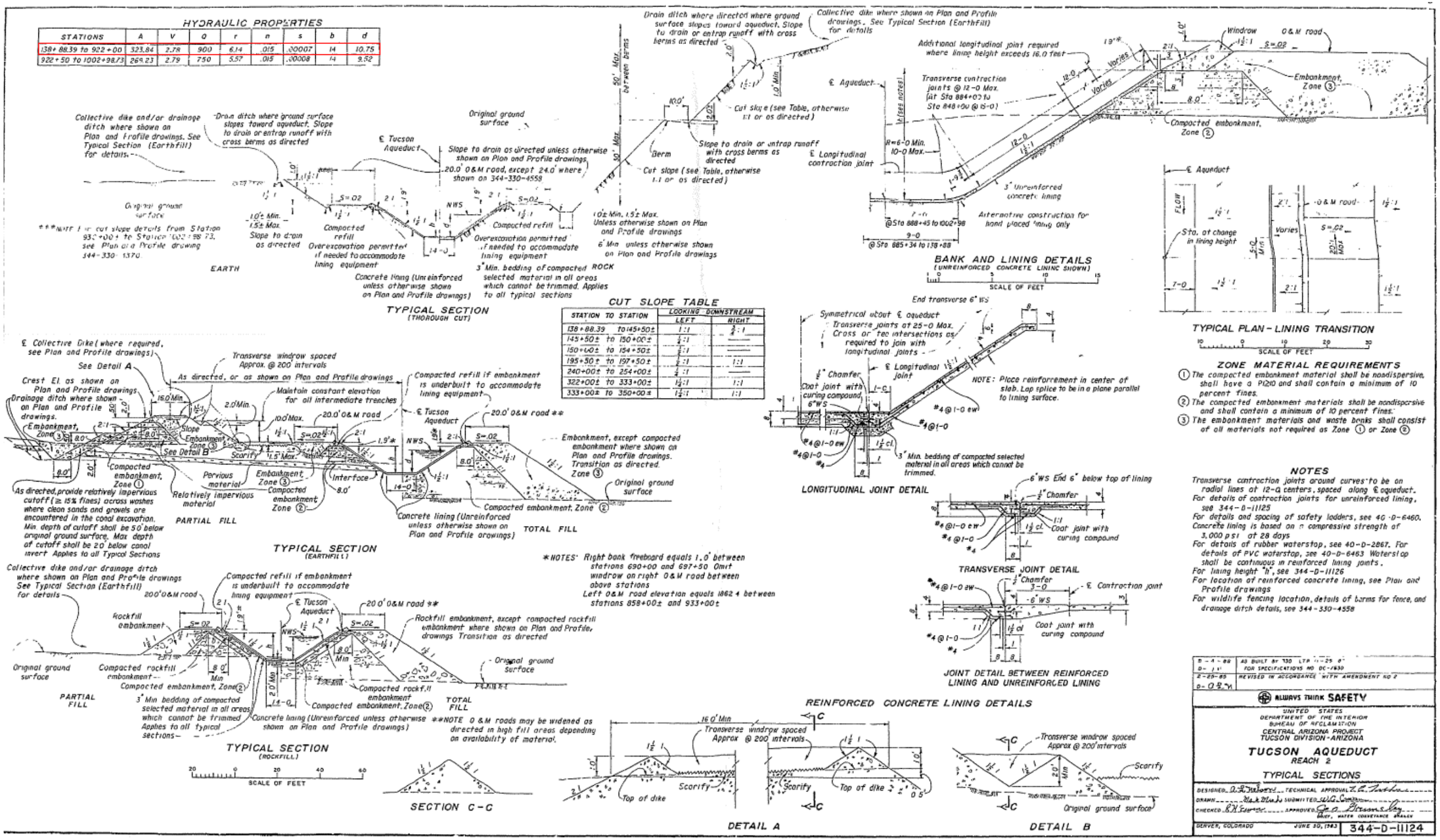
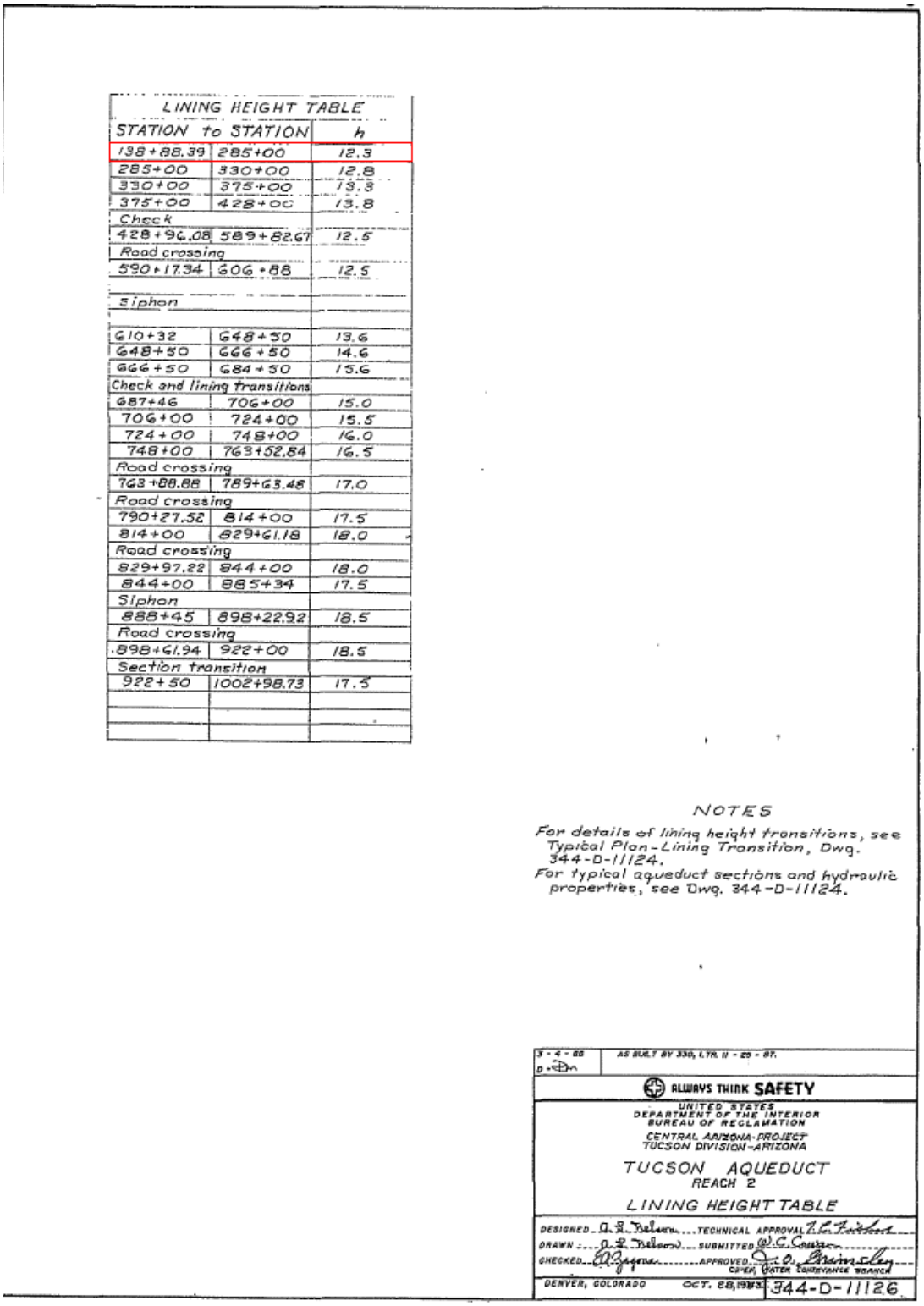


Figure 1 - Drawing of Typical Aqueduct Sections

Appendix D
Existing Canal Drawings



LINING HEIGHT TABLE

STATION	to STATION	h
138+88.39	285+00	12.3
285+00	330+00	12.8
330+00	375+00	13.3
375+00	428+00	13.8
Check		
428+94.08	589+82.67	12.5
Road crossing		
590+17.34	606+88	12.5
Siphon		
610+32	648+50	13.6
648+50	666+50	14.6
666+50	684+50	15.6
Check and lining transitions		
687+46	706+00	15.0
706+00	724+00	15.5
724+00	748+00	16.0
748+00	763+52.84	16.5
Road crossing		
763+88.88	789+63.48	17.0
Road crossing		
790+27.52	814+00	17.5
814+00	829+61.18	18.0
Road crossing		
829+97.22	844+00	18.0
844+00	885+34	17.5
Siphon		
888+45	898+22.92	18.5
Road crossing		
898+61.94	922+00	18.5
Section transition		
922+50	1002+98.73	17.5

NOTES

For details of lining height transitions, see Typical Plan-Lining Transition, Dwg. 344-D-11124.
For typical aqueduct sections and hydraulic properties, see Dwg. 344-D-11124.

3-4-68 D-EDN — AS BUILT BY 350, LTR. 11-25-87.

ALWAYS THINK SAFETY

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
CENTRAL ARIZONA PROJECT
TUCSON DIVISION-ARIZONA

TUCSON AQUEDUCT
REACH 2

LINING HEIGHT TABLE

DESIGNED D.R. Nelson — TECHNICAL APPROVAL T.C. Fitchett
DRAWN D.R. Nelson — SUBMITTED W.G. Swan
CHECKED E.A. Zigan — APPROVED J.O. Ramsley, CHIEF, WATER CONVEYANCE BRANCH
DENVER, COLORADO OCT. 28, 1983 — 344-D-11126

Figure 2 - Lining Height Table