Sequence of Work & Narrative
Lyons Dam Removal & Toewood Bench Construction at Lyons, MI
for the
Village of Lyons & the Ionia County Conservation District

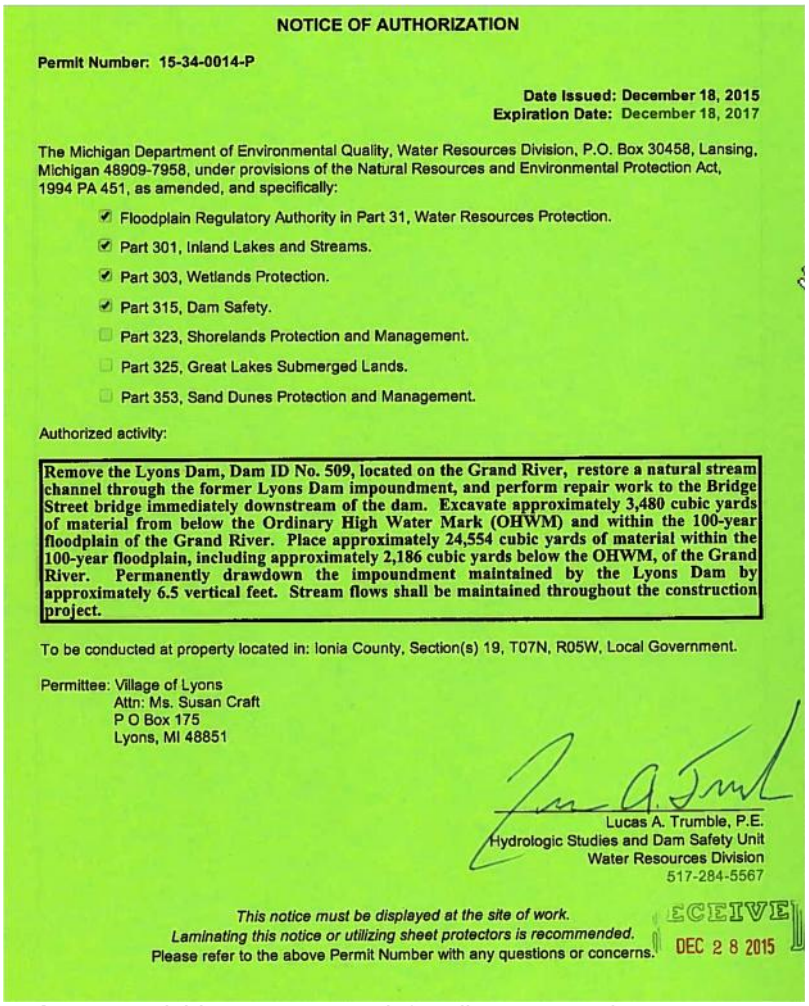
Situation

Figure 1. Face of Lyons Dam about 8 years apart.

This sequence of work directly follows the Emergency West Bank Stabilization at the West end of the Dam and Bridge at Lyons, MI (written June 1, 2016). It is the same as the original Sequence of Work written in January of 2016 with two exceptions. First, there is no work in the East Channel or on Hazel Devore Island and second, Vane 3 included with the original "west end" work is now included here along with removal of the Lyons Dam and construction of the Toewood Bench upstream of the dam.

Figure 1 shows the dam face in 2008 and 2016. While the surface of the dam is now more pitted and some splayed off holes on the face of the dam have enlarged, the end run of water around the west end and subsequent bank erosion there has forced a speed up in the awarding of bids. This sequence is funded with federal funds from the US Fish and Wildlife Service, and it is anticipated these funds will be available for spending at the completion of the Emergency Work at the West End which is funded by state funds that are currently available for spending.

There may be a gap between completion of the Emergency Work and the Dam Removal and Toewood Construction Work. If so, appropriate demobilization and mobilization costs apply. The Bid Items accompanying this Sequence of Work will have two options; one with no gap and one with a gap in time between operations. The same Michigan DEQ Permit 15-34-0014P applies for the original, Emergency and this Sequence of Work (Figure 2).



NOTICE OF AUTHORIZATION

Permit Number: 15-34-0014-P

Date Issued: December 18, 2015
Expiration Date: December 18, 2017

The Michigan Department of Environmental Quality, Water Resources Division, P.O. Box 30458, Lansing, Michigan 48909-7958, under provisions of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and specifically:

- ☑ Floodplain Regulatory Authority in Part 31, Water Resources Protection.
- ☑ Part 301, Inland Lakes and Streams.
- ☑ Part 303, Wetlands Protection.
- ☑ Part 315, Dam Safety.
- ☐ Part 323, Shorelands Protection and Management.
- ☐ Part 325, Great Lakes Submerged Lands.
- ☐ Part 353, Sand Dunes Protection and Management.

Authorized activity:

Remove the Lyons Dam, Dam ID No. 509, located on the Grand River, restore a natural stream channel through the former Lyons Dam impoundment, and perform repair work to the Bridge Street bridge immediately downstream of the dam. Excavate approximately 3,480 cubic yards of material from below the Ordinary High Water Mark (OHWM) and within the 100-year floodplain of the Grand River. Place approximately 24,554 cubic yards of material within the 100-year floodplain, including approximately 2,186 cubic yards below the OHWM, of the Grand River. Permanently drawdown the impoundment maintained by the Lyons Dam by approximately 6.5 vertical feet. Stream flows shall be maintained throughout the construction project.

To be conducted at property located in: Ionia County, Section(s) 19, T07N, R05W, Local Government.

Permittee: Village of Lyons
Attn: Ms. Susan Craft
P O Box 175
Lyons, MI 48851

Lucas A. Trumble, P.E.
Hydrologic Studies and Dam Safety Unit
Water Resources Division
517-284-5567

This notice must be displayed at the site of work.
Laminating this notice or utilizing sheet protectors is recommended.
Please refer to the above Permit Number with any questions or concerns.

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Figure 2. Michigan DEQ Permit for all stream work at Lyons, MI.

Existing Conditions

Figure 3 (page 4) identifies existing conditions in the Lyons Grand River Project Area. Figures containing layout sheets can be printed in sharp detail as pdf files (included in a digital folder) at any paper size desired. The dam at (A) has several holes in the face concrete and a large hole below the dam at the west end. During floods, water makes an end run around the west end abutment of the dam (B) eroding the high bank there just below residences and undermining the west abutment of the Bridge Street Bridge. Emergency dumping of rip rap at (C) has temporarily stalled the erosion. Further bank erosion occurs downstream of the bridge on the high bank at (D). Large cobble and small boulders were used in the past in large amounts to form in channel roads along the base of the dam and along the bridge piers (it is dug out between piers now) and to shield sewage lines under the river downstream of the bridge. Over the years, floodwaters have moved the cobble and gravel downstream where it was deposited on the riffle north of Hazel Devore Island (E). The riffle expanded and grew in height so that bankfull and floodwater are forced against the sand bank of Hazel Devore Island. The island has lost 30 to 50 feet of its width over a distance of ~500 feet (F).

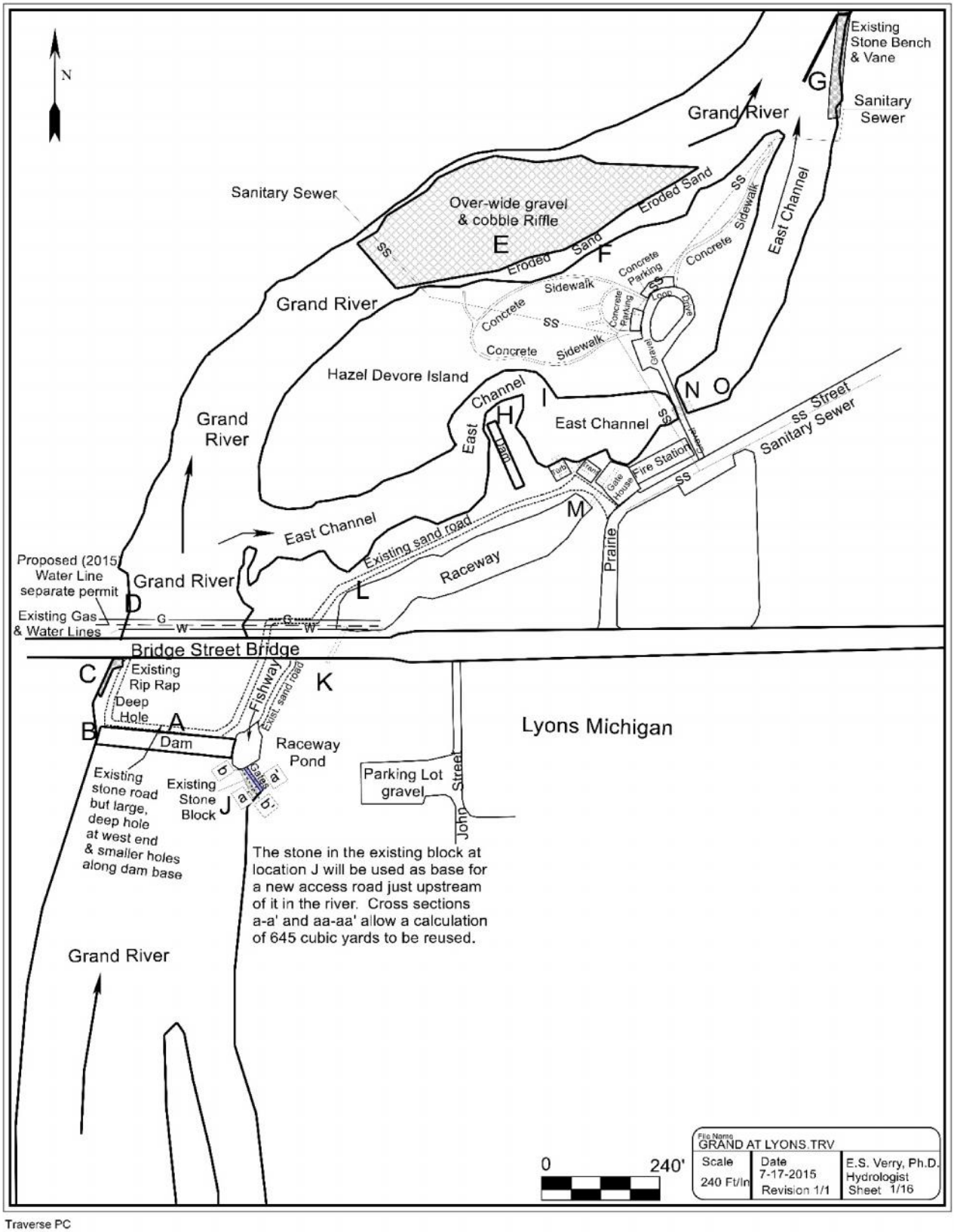


Figure 3. See text on the previous and the following pages for a description of the large capital letters. Cross sections (a-a' and b-b') at J, the existing stone block, are shown in **Figures 4 and 5**.

Bank erosion at G came within a few feet of the sewage lift station, so, in 2012, a stone bankfull bench and a straight vane were installed under an emergency permit to protect the sewage lift station. An old, smaller dam at G (Hale Mill Dam) also forced an end run of water to the north cutting into the Hazel Devore Island on the south side ~375-feet and causing current high rates of erosion at (I). Emergency conditions were declared at the raceway gates (J) where erosion under and through the gates sent high velocity water through the raceway pond, under Bridge Street (K) to the North and began eroding the sand access road along the north side of the Raceway Channel (L). Flow from the raceway (M) is combined with flow in the East Channel and backed-up against the causeway (N) between Hazel Devore Island and the town of Lyons. The backup is caused by undersized culverts in the causeway (N) (the city will replace the causeway with a bottomless arch culvert in the future when funds allow). High velocities through the undersized culverts in the causeway are threatening home decks and foundations downstream of the causeway (O). Blocking stone was placed just upstream of the raceway gates (J) by DNR Fisheries in 2011 to minimize the eroding flow pattern set up in the raceway, but high velocities still exit the causeway culverts.

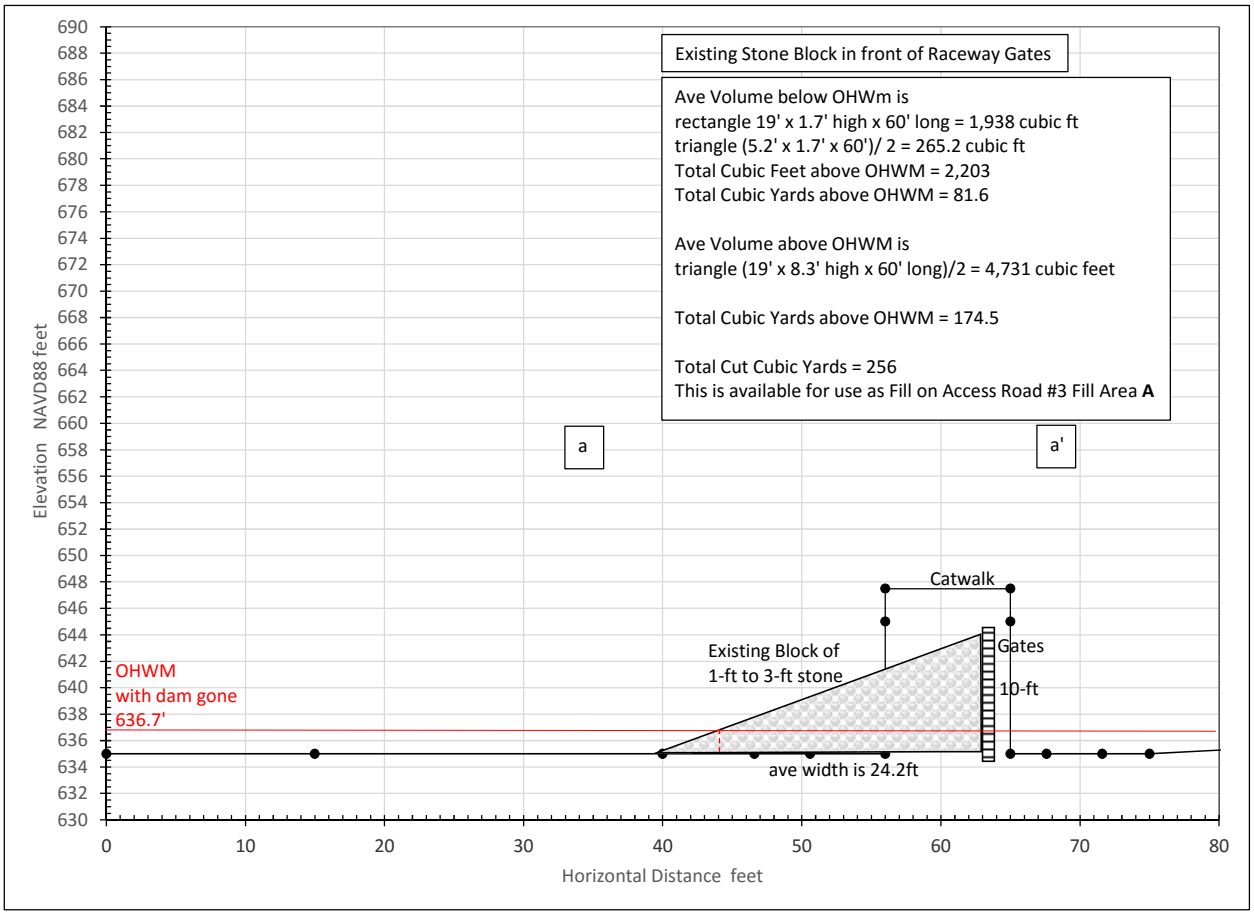


Figure 4. Cross section a-a' at J on layout sheet 1/16 and **Figure 3**.

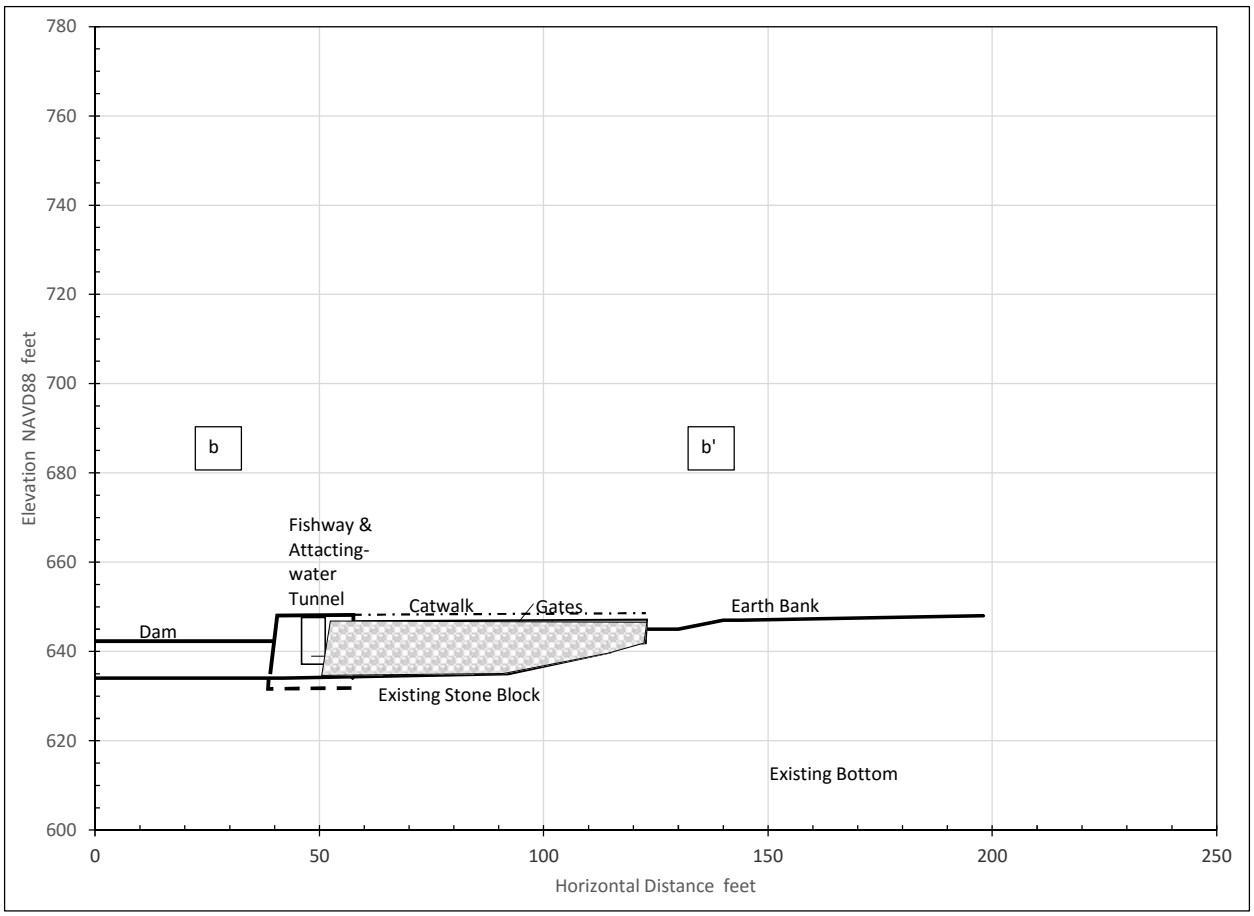


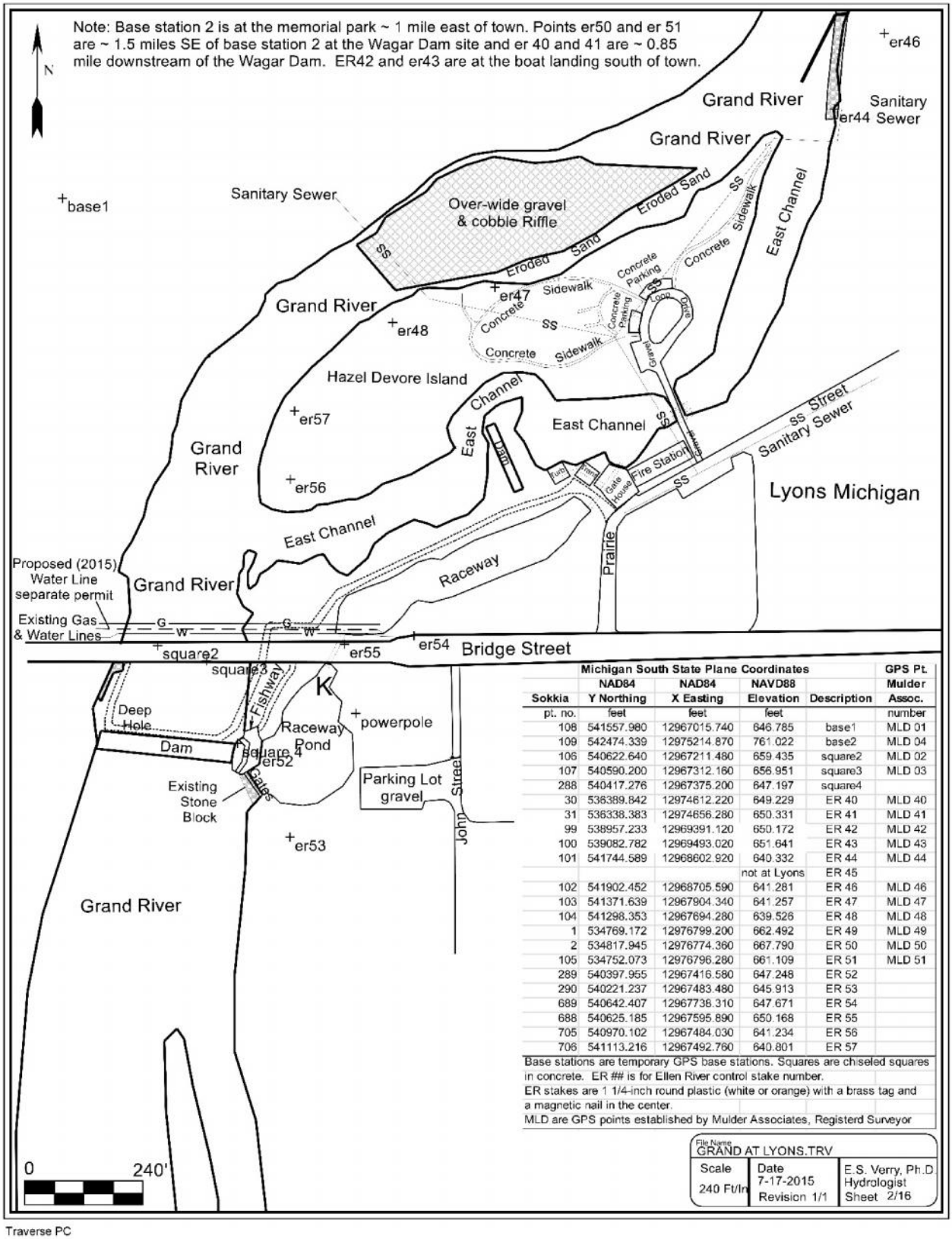
Figure 5. Longitudinal section b-b' at J on layout sheet 1/16 and Figure 2

Survey Work and Control Points

A survey of the Grand River and its islands was conducted by Ellen River Partners in July 2009. Quality control for the survey was provided by Mulder Associates, State of Michigan, Registered Surveyors who provided GPS, State Plane Coordinates and NADV88 elevations for Ellen River Partners' control points. Ellen River subsequently added several other control points. The locations, coordinate and elevation data for control points are shown in **Figure 6 (**page 7).

Survey work was conducted from just south of the Grand River Dam (south to the north protruding peninsula on river right) to the river bend just north of Hazel Devore Island. Adjusted elevations from the USGS topo map were added to ground survey work particularly on the high bank west and south of the dam. A 1-foot contour map was constructed using professional surveying software (Traverse PC) and is shown in **Figure 7** (page 8). This contour map is the basis for a large number of project cross sections. The plan view area of various fill and rip rap areas is sometimes used from the software program and multiplied by the average depth to yield volumes; otherwise the length, width and thickness of fill areas are multiplied together for volume calculations.

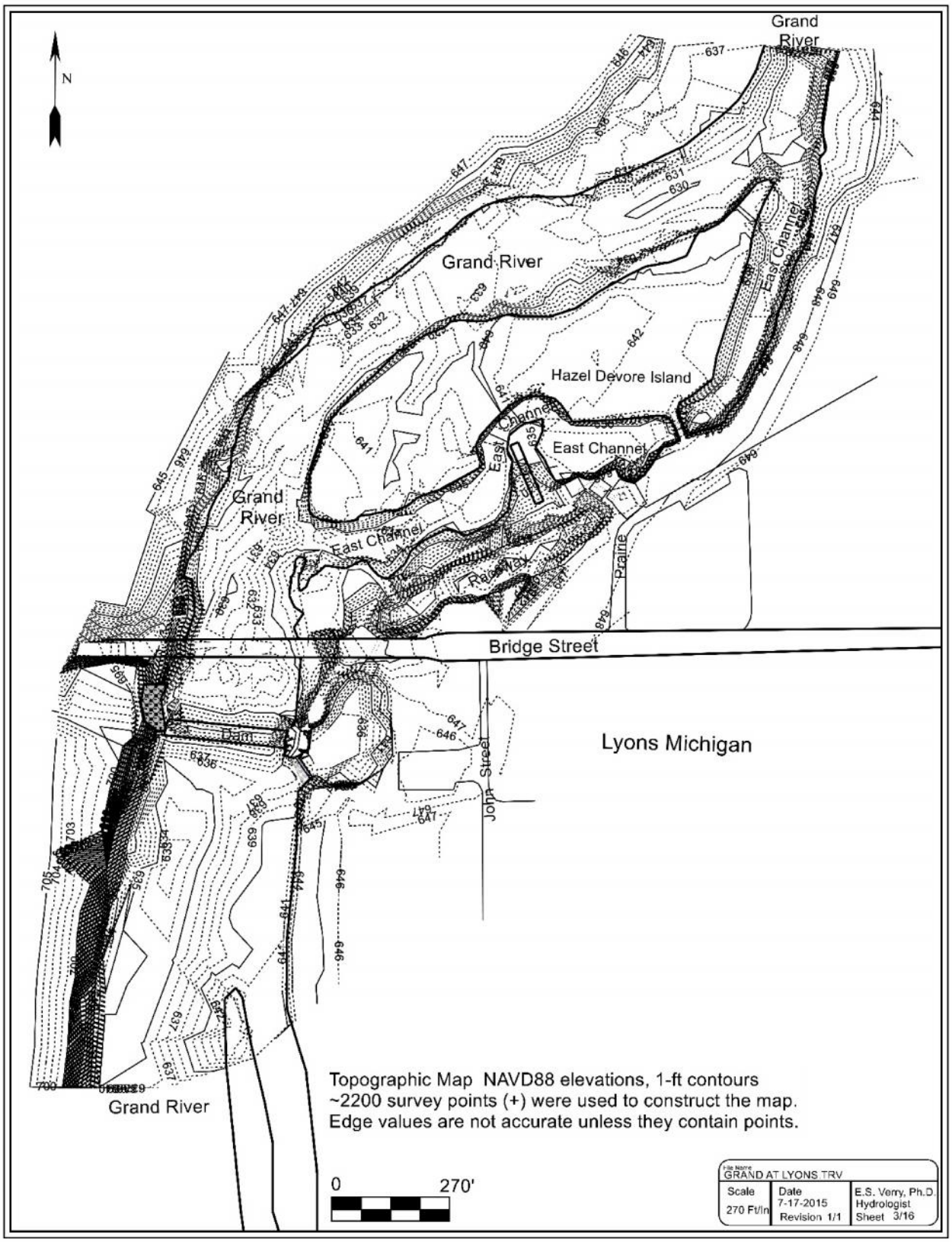
The sequence of work outlined here is likely, but may vary depending on water levels and the timing available to different contractors working in the Project Area.



	Michigan South State Plane Coordinates				GPS Pt.
	NAD84	NAD84	NAVD88		Mulder
Sokkia	Y Northing	X Easting	Elevation	Description	Assoc.
pt. no.	feet	feet	feet		number
108	541557.980	12967015.740	646.785	base1	MLD 01
109	542474.339	12975214.870	761.022	base2	MLD 04
106	540622.640	12967211.480	659.435	square2	MLD 02
107	540590.200	12967312.160	656.951	square3	MLD 03
288	540417.276	12967375.200	647.197	square4	
30	538389.842	12974612.220	649.229	ER 40	MLD 40
31	536338.383	12974656.280	650.331	ER 41	MLD 41
99	538957.233	12969391.120	650.172	ER 42	MLD 42
100	539082.782	12969493.020	651.641	ER 43	MLD 43
101	541744.589	12968602.920	640.332	ER 44	MLD 44
			not at Lyons	ER 45	
102	541902.452	12968705.590	641.281	ER 46	MLD 46
103	541371.639	12967904.340	641.257	ER 47	MLD 47
104	541298.353	12967694.280	639.526	ER 48	MLD 48
1	534769.172	12976799.200	662.492	ER 49	MLD 49
2	534817.945	12976774.360	667.790	ER 50	MLD 50
105	534752.073	12976796.280	661.109	ER 51	MLD 51
289	540397.955	12967416.580	647.248	ER 52	
290	540221.237	12967483.480	645.913	ER 53	
689	540642.407	12967736.310	647.671	ER 54	
688	540625.185	12967595.890	650.168	ER 55	
705	540970.102	12967484.030	641.234	ER 56	
706	541113.216	12967492.760	640.801	ER 57	

Base stations are temporary GPS base stations. Squares are chiseled squares in concrete. ER ## is for Ellen River control stake number.
ER stakes are 1 1/4-inch round plastic (white or orange) with a brass tag and a magnetic nail in the center.
MLD are GPS points established by Mulder Associates, Registerd Surveyor

Figure 6. Control point locations with State Plane coordinates and NAVD88 elevations.



Traverse PC

Figure 7. Surveyed, 1-foot, contour map of the Lyons, MI Project Area.

Proposed Access Roads

Originally, there were six access roads into the river. They are all on existing sand surfaces. Some utilize existing roads and all have steep segments where the road enters the river or enters the raceway pond where spoil from the dam will be kept. Access Road #1 has been completed under the Emergency Sequence of Work for the West End. Only Access Road #3 and the existing sand Access Road #6 are needed for the Dam Removal and Toewood Construction detailed in this Sequence of Work. **Figure 8** shows the location of the access roads and their steeper segments.

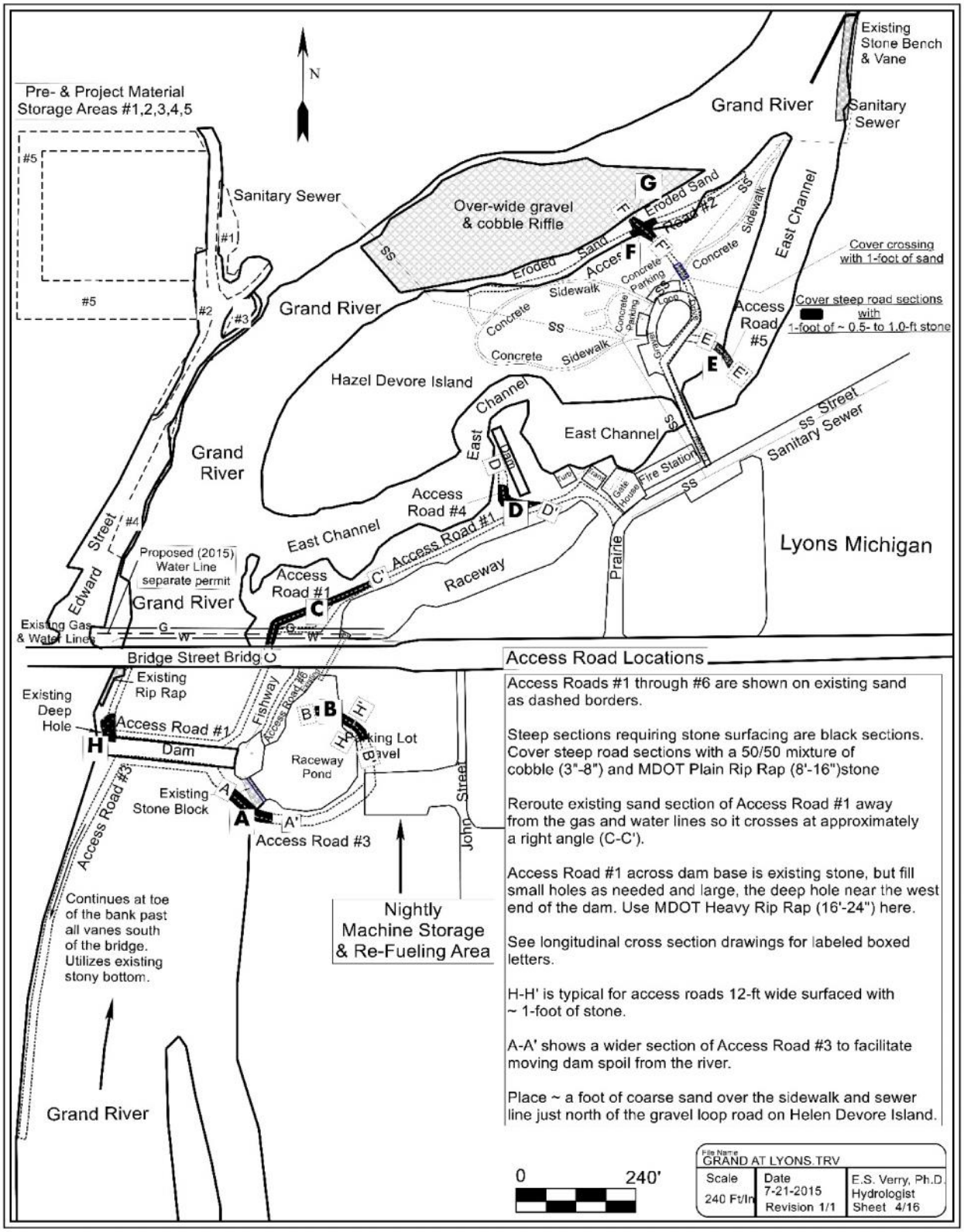


Figure 8. Proposed access roads #1 through #6. Black segments show steep portions where a surfacing of stone is needed to provide stability. Note also the sand cover at the east concrete walkway, the designated Machine Storage & Re-Fueling Area and the Storage Areas (1-5) above the 100-yr flood.

Access roads are typically 12-feet wide and a foot deep where they are surfaced with a 50/50 mixture of cobble (3" to 8"diameter) and MDOT Plain rip rap (8" to 16" stone) on steep sections where a stable footing is required (H-H' typical cross section) see **Figure 9**. Some segments are wider at 25-feet wide where off road trucks must pass and will be shown separately.

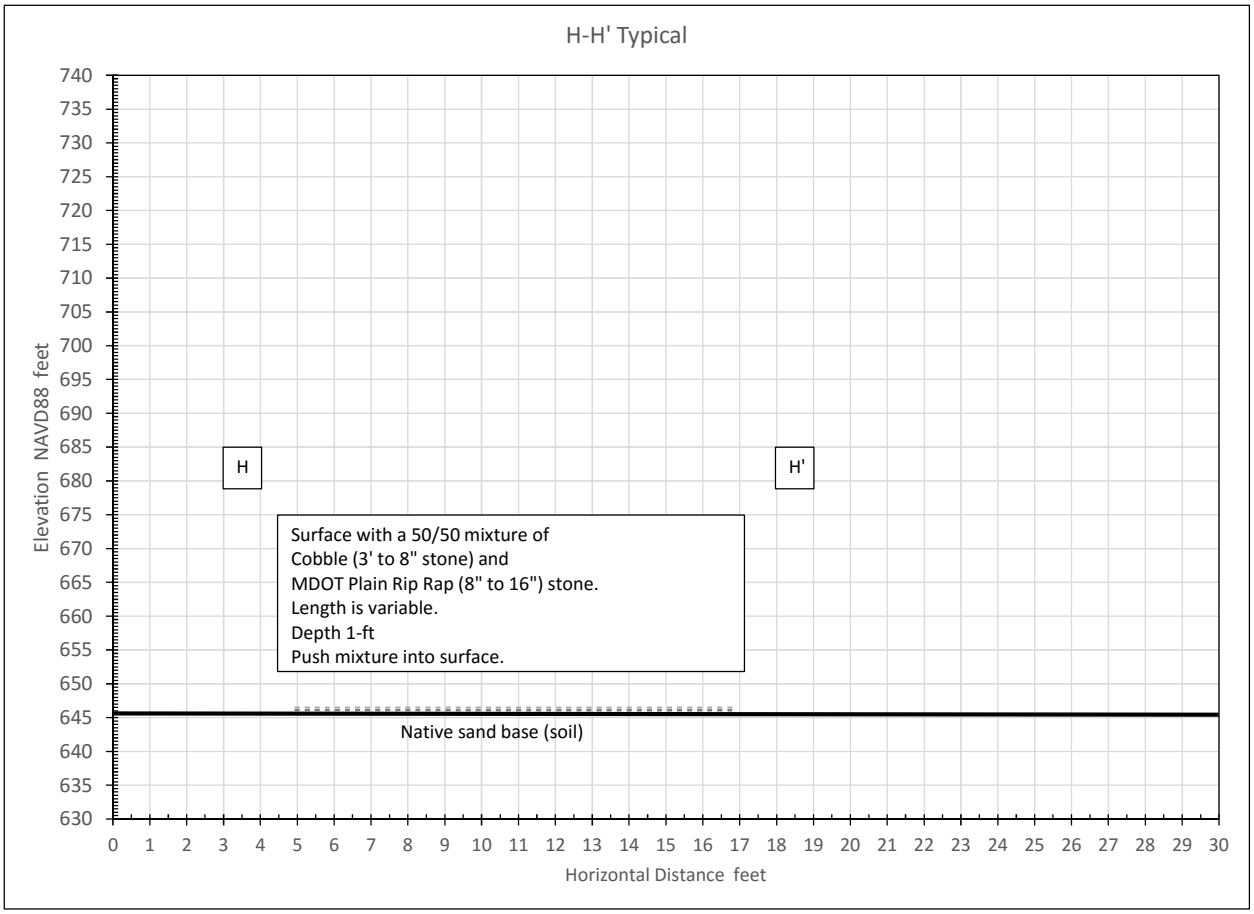


Figure 9. A typical cross section of sand roads on steep segments where a stable footing is required.

A longitudinal section for the steep segments of access roads show their extent and surfacing volume calculations (**Figure 15**). Note that Access Road #6 is an existing sand road on level ground and requires no surfacing.

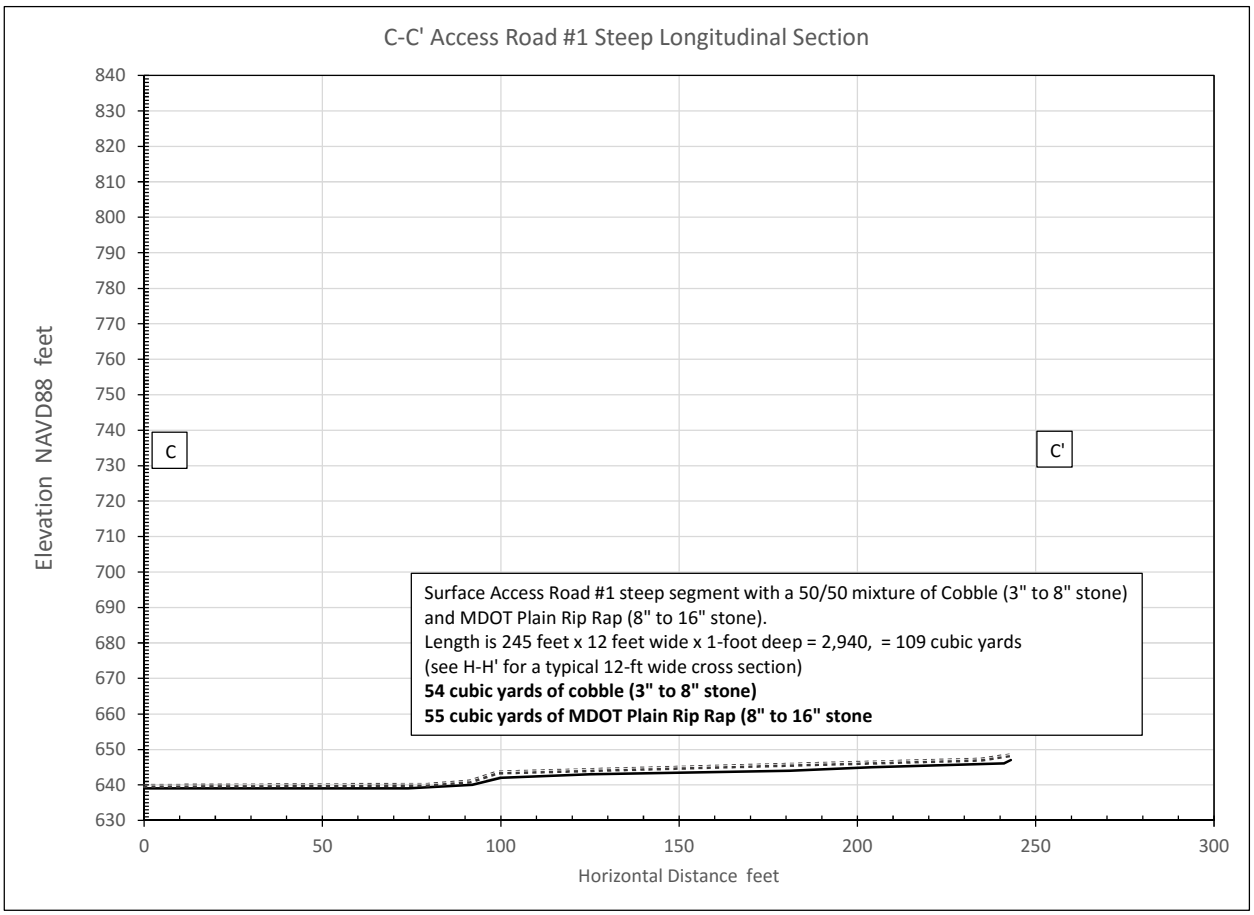


Figure 15. Access Road #1 longitudinal section (*COMPLETED UNDER THE EMERGENCY WEST END WORK*).

BE MINDFUL OF OVERHEAD POWERLINES AT THE BEGINNING OF ACCESS ROAD #1 NEAR THE SUBSTATION AND POWERHOUSE (FIG. 8) AND MAKE SURE OFFROAD TRUCKS AND EXCAVATORS WILL CLEAR THESE LINES. IF NOT PROVIDE SUPPORT FOR THE LINES SO THEY DO CLEAR.

Access Road #3 cannot be built until the dam is removed and will be shown after that sequence of work.

Dam Removal

Dam removal will require a very heavy breaker bar attached to a large excavator. The dam will be breached at low water (less than 650 cfs) when water depths on the downstream side of the dam should be 3-feet or less allowing operation of the excavator in the channel with the water level below the cab floor. The dam should be breached at the existing hole in the dam face (**Figure 16**). A second large excavator will be needed to remove and temporarily place the dam spoil.

A cross section of the dam and its construction sequence is shown in **Figure 17**.

The volume of dam spoil removed is summarized in **Table 1**. The measurements in the table were taken from a 1994 survey of the dam incorporating construction details by Ayers, Lewis, Norris and May, Inc. in drawings by Fleis and Vandenbrink Engineering, Inc.

Table 1. Dam spoil volume and possible available cobble under the dam shed roof and within its cribs.

DAM SPOIL & AVAILABLE COBLE VOLUME									
	Rectangle							**Expanded**	**Expanded**
	or	**ross Section**			**Dam**			**Volume**	**Volume**
	half rect.	**Height**	**Thickness**	**Area**	**Length**	**Volume**	**Volume**	**x1.25**	**x1.30**
Dam Concrete		ft	ft	sq ft	ft	cubic ft	cubic yards	cubic yards	cubic yards
Dam Downstream Face (1910)	1	20.3	1	20.3	280	5,684	211	263	274
Dam Upstream Face (1906)	1	13.7	2	27.4	280	7,672	284	355	369
Dam Upstream Rectangle (1932)	1	13.4	1.3	17.42	280	4,878	181	226	235
Dam Upstream Triangle (1932)	0.5	10	10	50	280	14,000	519	648	674
	Rectangle							**Expanded**	**Expanded**
	or	**Cross Section**			**Dam**			**Volume**	**Volume**
	half rect.	**Height**	**Width**	**Area**	**Length**	**Volume**	**Volume**	**x1.25**	**x1.30**
		ft	ft	sq ft	ft	cubic ft	cubic yards	cubic yards	cubic yards
Dam Bolster Downstream Rectangle (1932)	1	1.4	11.2	15.68	280	4,390	163	203	211
Dam Bolster Downstream Triangle (1932)	0.5	2.7	8.7	11.745	280	3,289	122	152	158
Dam Bolster added by DNR (19??) east end	1	0.5	6.7	3.35	100	335	12	16	16
West Abutment	1	16	2	32	30	960	36	44	46
Total Dam Concrete to Remove							1,526	1,908	1,984
Gross Crib Volume above 634'									
Downstream Crib & Shed Triangle Volume	0.5	9.7	19	92.15	280	25,802	956	1,195	1,242
Upstream Crib & Shed Triangle Volume	0.5	9.7	9	43.65	280	12,222	453	566	588
Total Gross Crib & Shed Volume							1,408	1,760	1,831
Interior Crib & Shed Wood Volume									
Interior Posts	1	4	3	12	280	3,360	124	156	162
Interior Beams & Boards	1	10	2	20	280	5,600	207	259	270
Interior Wood Volume estimate							332	415	431
Total Spoil Vol. (Concrete + Wood)							1,858	2,323	2,415
Net Interior Cobble Volume down to 634' *							1,076		
Uses for Interior Cobble									
Cobble Needed For New Riffle 634'-635.5'	1	1.5	36	54	280	15,120	560		
Cobble Needed For Access Road #3	1	1.5	25	37.5	280	10,500	389		
Splash Apron Volume For Vane # 3	0.5	2	34	78		2,652	98		
							1,047		
Left over cobble ? (can be used in Area $_W$)							29		
* The true amount of cobble available within the dam is unknown because of holes eroded under the dam.									
There has probably been some substitution of patching conrete for cobble over the years.									

About 1,900 cubic yards of spoil will be removed, but this will expand to about 2,500 cubic yards (30% increase as it is loaded, transported and placed in the raceway pond. There may be as much as 1,076 cubic yards of cobble under the dam shed roof and within its cribs.

The possible amount of cobble available can be used for the new riffle (about 1.5 feet of cobble) placed above the 634-foot cut elevation to reach a riffle elevation of 635.5 feet, the base of Access Road #3 just upstream and parallel to the dam and the splash apron for vane #2. The true amount of cobble available is unknown because there has probably been some substitution of patching concrete for cobble over the years.

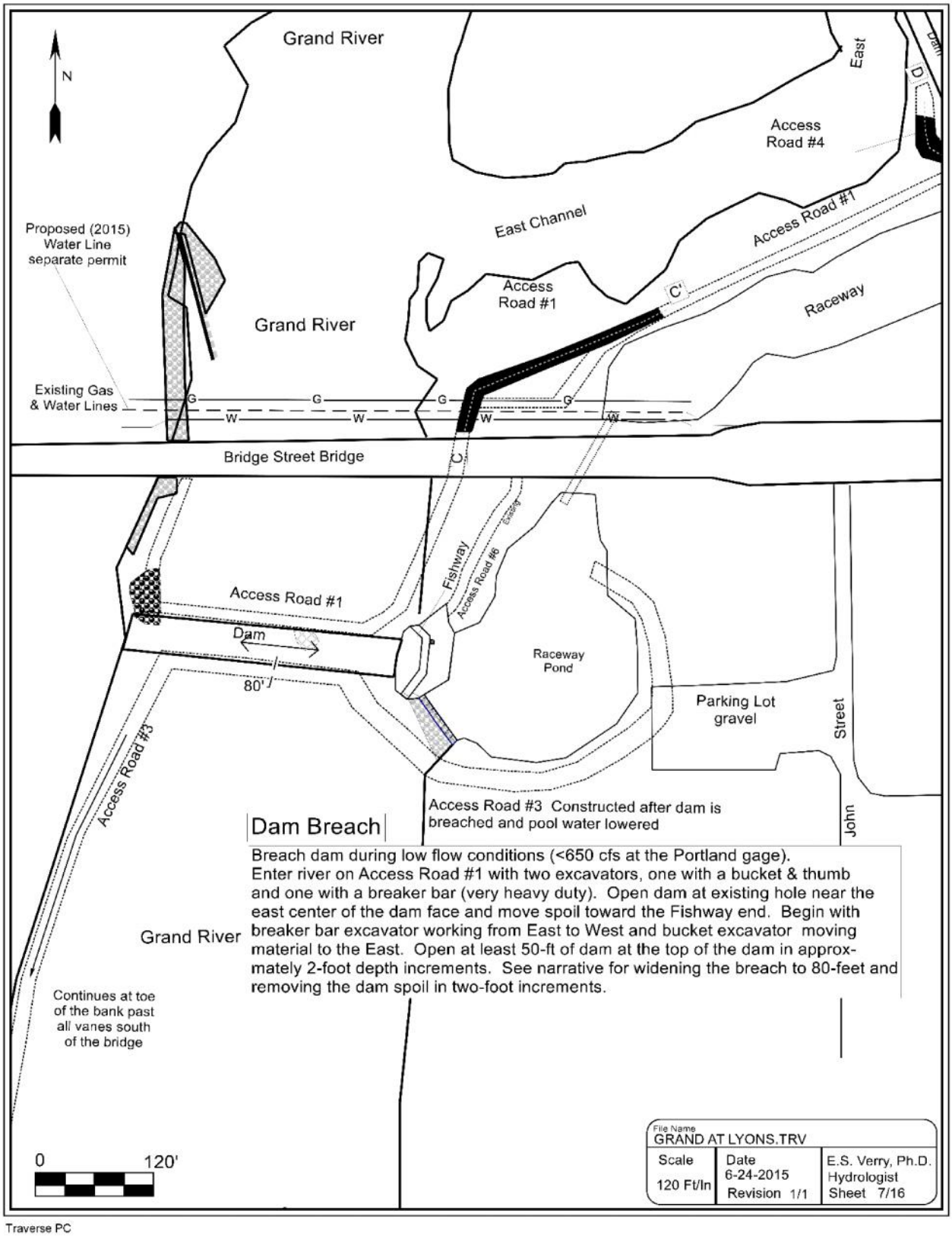


Figure 16. Begin dam breach at hole on downstream face with a 50-foot wide hole at the top of the dam that is two-feet deep, enlarge to 80-feet as the water level recedes.

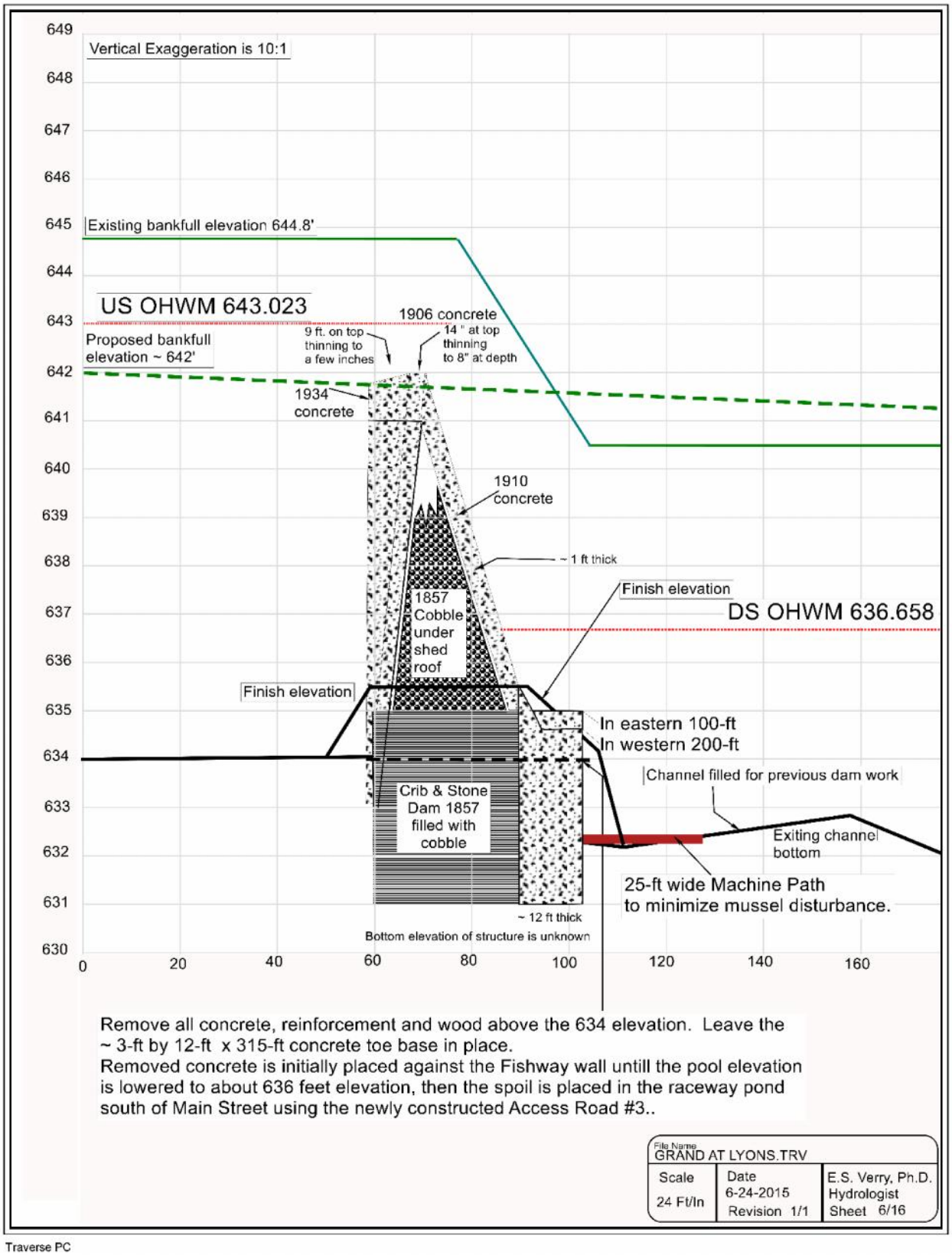


Figure 17. Cross section of the Lyons Dam showing the year of construction (1857) and the years when concrete was added to reinforce the dam.

Begin by removing the top two feet of the dam above the downstream hole. Enlarge this two-foot deep section by about 50 feet in the horizontal. Keep the breaker bar excavator on the west side of the hole and keep the bucket and thumb excavator on the fishway side to pull spoil back toward the fishway where it will be stored temporarily until the pool behind the dam is reduced to an elevation of about 367 feet.

Wait for the pool elevation to drop two feet (half or perhaps all of a day) then enlarge the breach width to 80-feet by removing the top two feet of the dam 30 feet to the west. The breach should be approximately in the middle of the dam at this point.

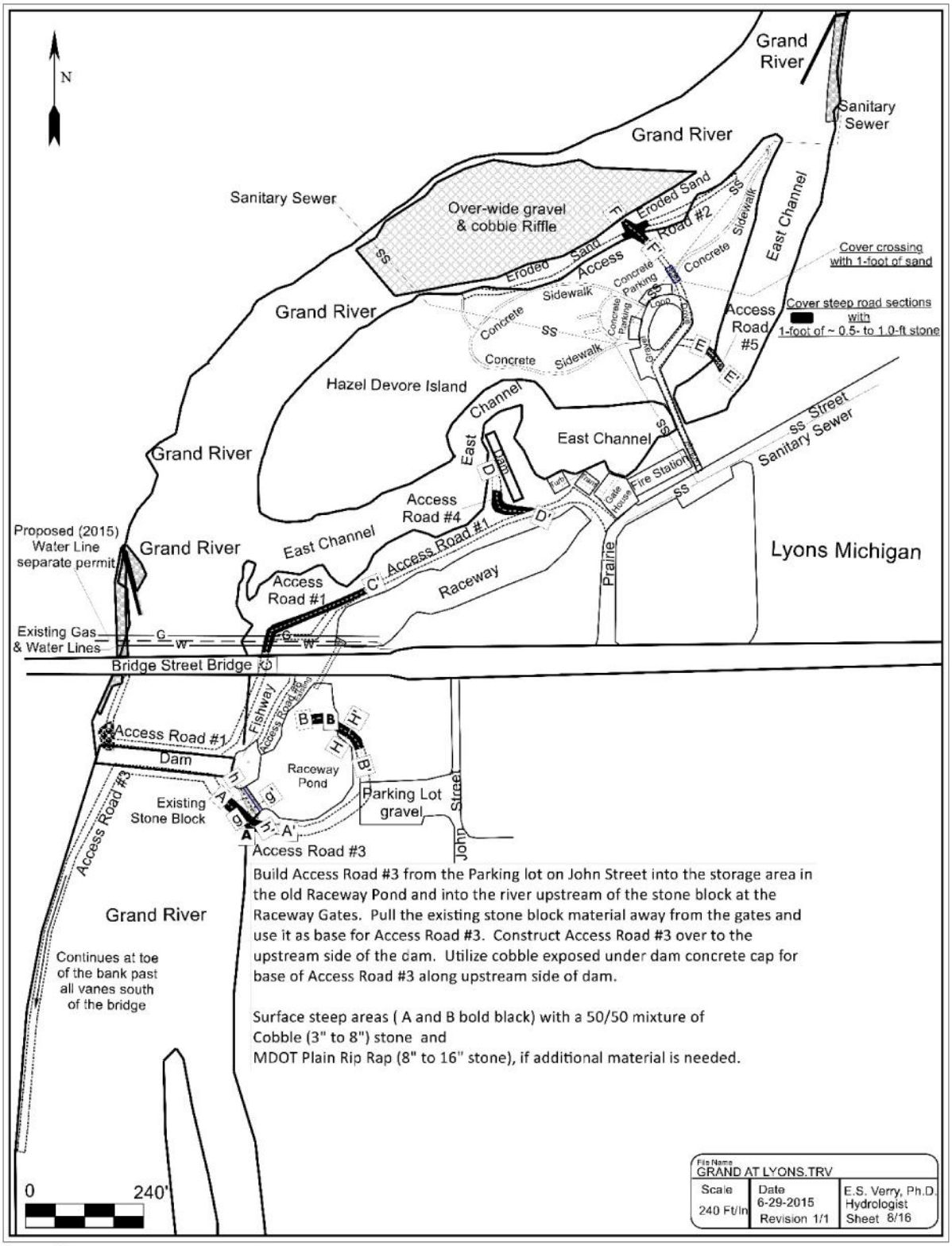
Working first from the middle of the breach remove another two-foot depth and place debris back toward the fishway. Work slowly both east and west until the 80-foot breach is now 4-feet deep.

Repeat this procedure for a third two-foot drop after the pool elevation has rescinded to 4-feet below the dam crest. **At any time during this dam removal, spoil can also be pushed or lifted over to the upstream side of the dam, but it should be on either side of the breach hole. When the water level has reached 367 feet or less, Access Road #3 can be constructed on the upstream side of the dam. Part of this construction will be moving any upstream spoil into the raceway pond storage area**.

When the pool elevation has rescinded 6-feet below the dam crest, repeat the procedure by a fourth two-foot drop in the 80-foot wide breach. Wait for the water level to rescind to an elevation 637 feet or less. Now construction of Access Road #3 can begin upstream of the dam.

Build Access Road #3 and Raceway Pond Fill

Enter the river upstream of the raceway pond gates and pull the existing stone block there away from the raceway gates to form the base of Access Road # 3 upstream of the gates (**Figure 18**).



Traverse PC

Figure 18. Build Access road #3 from the west end of the parking lot on John Street into the river upstream of the raceway pond gates. When the raceway pond is low enough build it into the pond.

Cross section g-g' through the existing stone block upstream of the raceway gates is shown in **Figure 19**. Cross section a-a' was shown previously on page 4. The longitudinal section A-A' combined with cross section h-h' are shown in **Figure 20**. Cross section g-g' is shown in **Figure 20** and cross section B-B' in **Figure 21**.

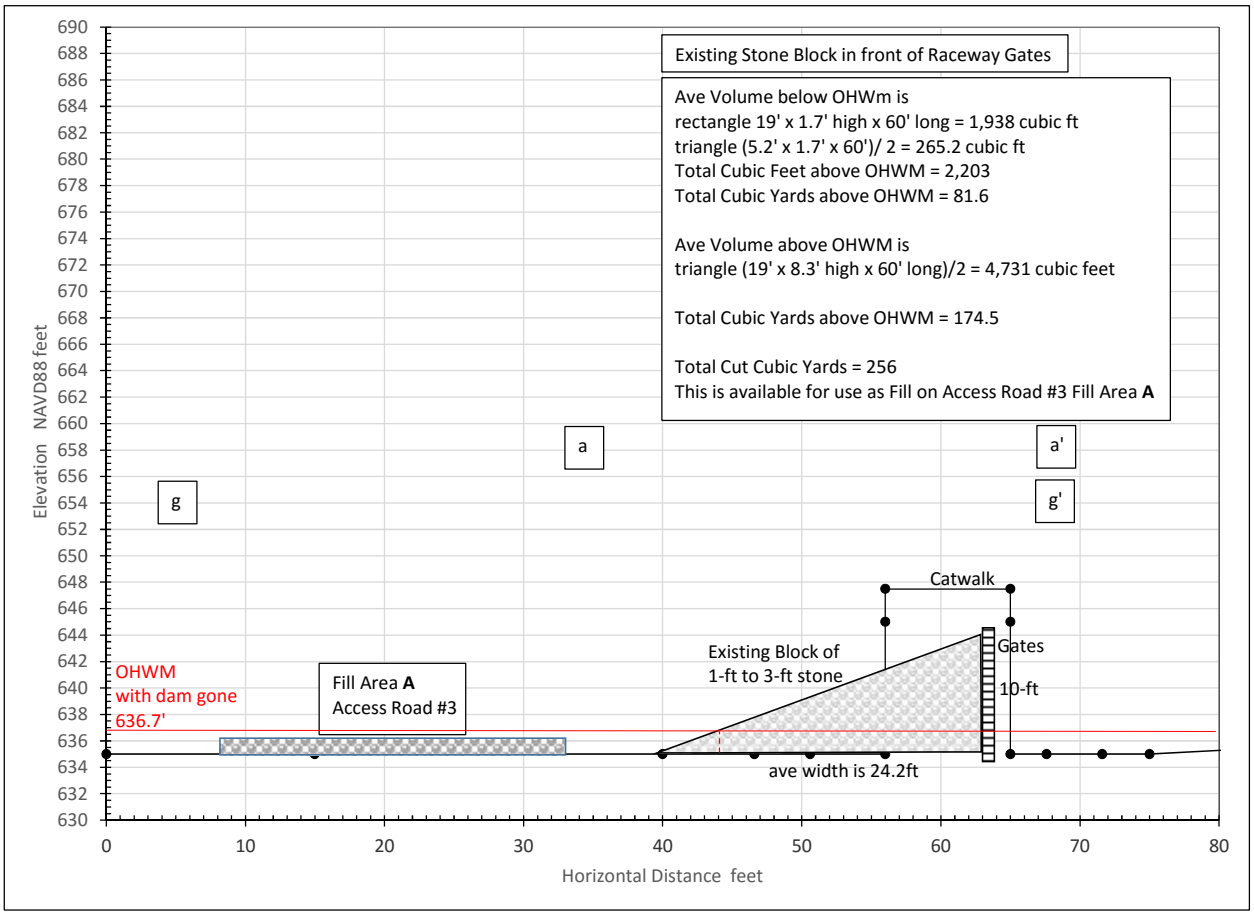


Figure 19. Cross section g-g' showing the stone block used as a base for Access Road #3.

Longitudinal section A-A' shows the entire length of the steeper portion of Access Road #3 (**Figure 25**).

Longitudinal section h-h' shows the raceway gates exposed after the existing stone block is pulled away from the gates and used for part of Fill Area **A** on the steeper portion of Access Road #3 (**Figure 25**).

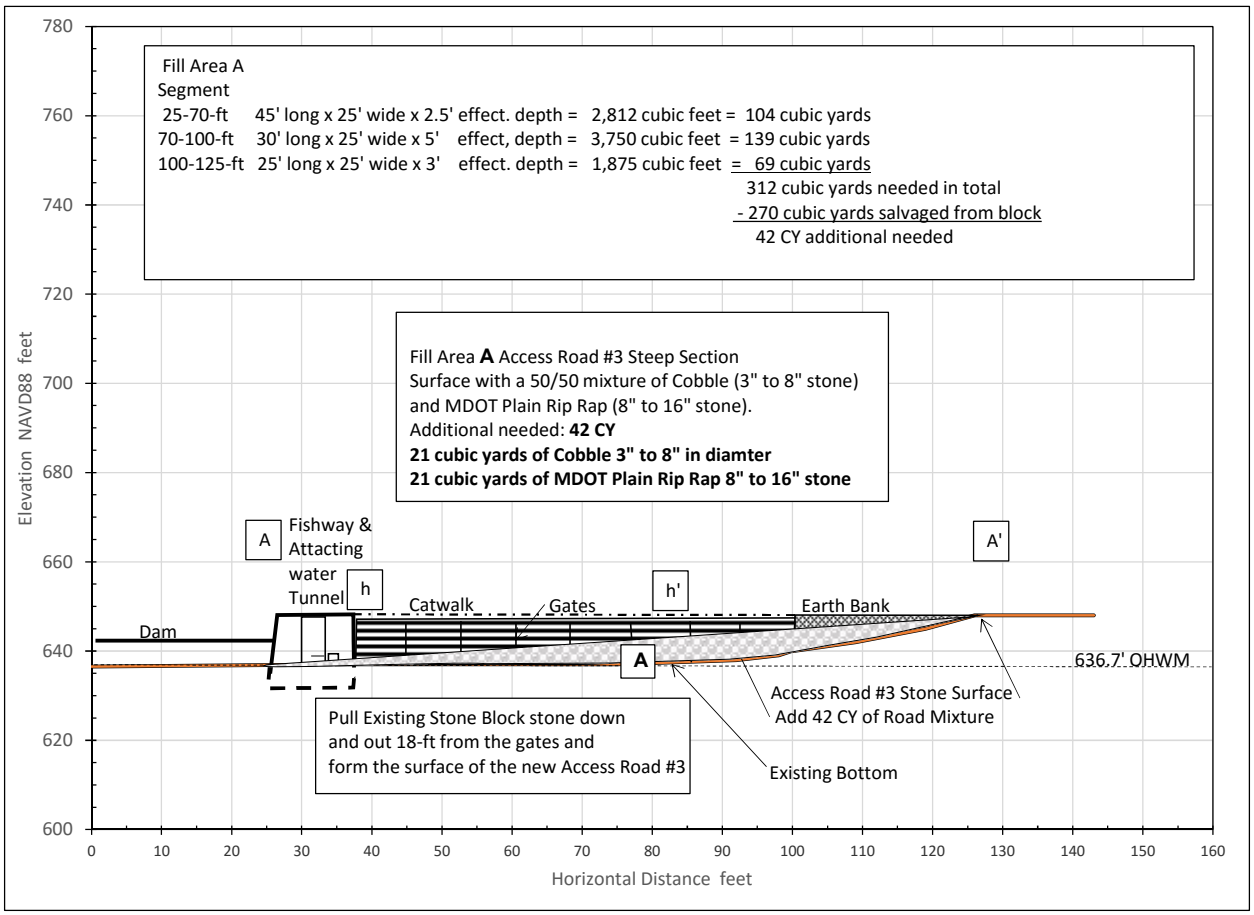


Figure 20. Access Road #3 Fill Area **A** after the stone block material has been incorporated into the road. Note the roadway is 25-feet wide to accommodate two way off-road truck traffic in the Grand River channel proper.

Longitudinal section B-B' shows the steep portion of Access Road #3 entering the raceway pond (**Figure 21**).

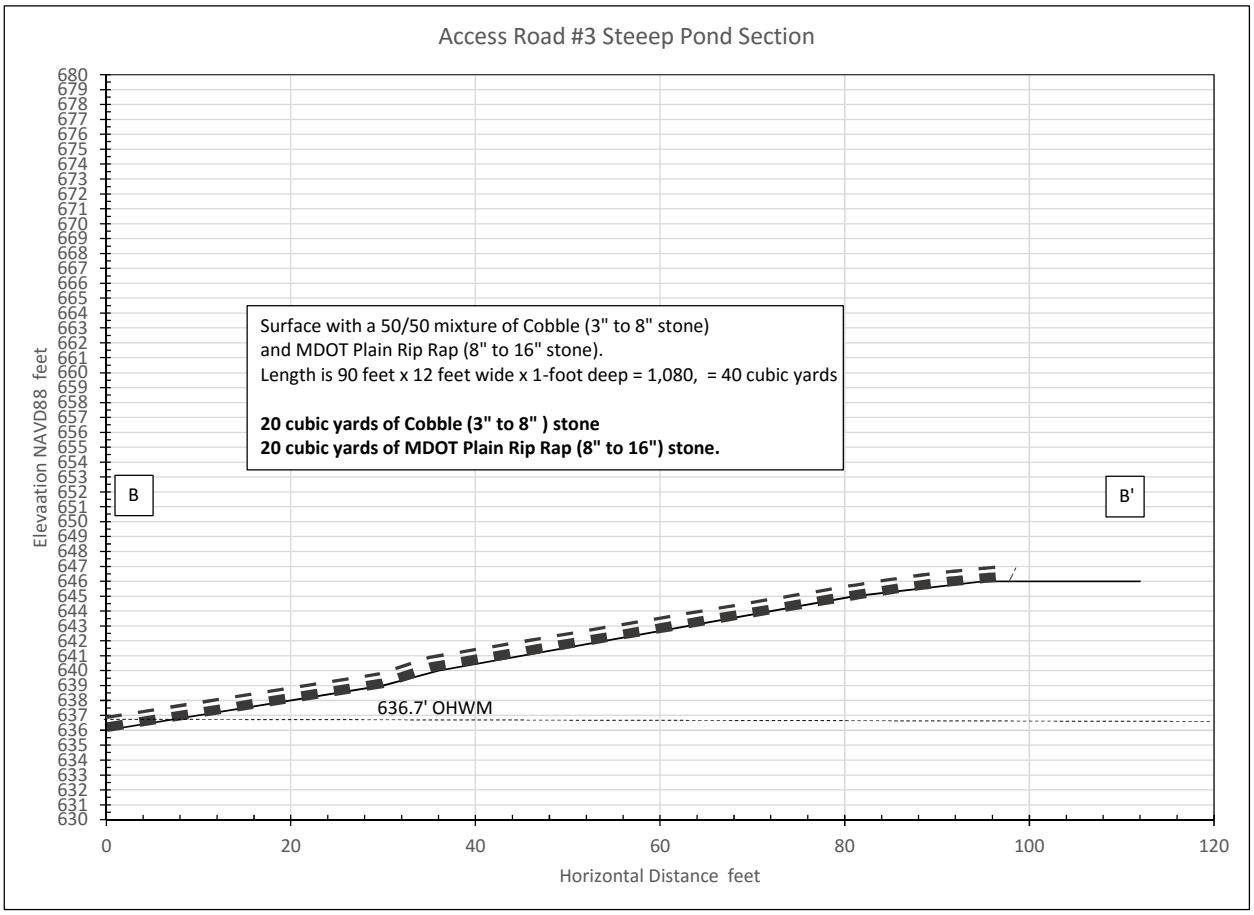


Figure 21. Access Road #3 steep segment entering the raceway pond. This is longitudinal section B-B'.

Raceway Gate, Fishway and Raceway Culvert Clay Seals

After the water level behind the partial dam and in the raceway pond has receded to about 636 feet elevation, the raceway gates are sealed with a clay block on the upstream side that is protected with a surface of 3-foot stone. The pond side of the gates is protected with a wedge of MDOT Heavy Rip Rap. (**Figure 22**).

A clay seal is also constructed over the south end of the large culvert that leaves the north end of the raceway pond. It will be covered with dam spoil, a clay cover for the spoil and finished with topsoil.

The north end of the large culvert under Bridge Street is sealed with MDOT Heavy Rip Rap.

Clay is also used to fill the fishway proper, its entry ways, its exit and the square manhole access on the east side of the fishway. The clay fill is finished with top soil while the clay blocks at the entrance and exit are protected with a surface of 3-foot stone to withstand ice movement. **Figure 22** identifies the various fills in plan-view, a closer view is shown in **Figure 23**..

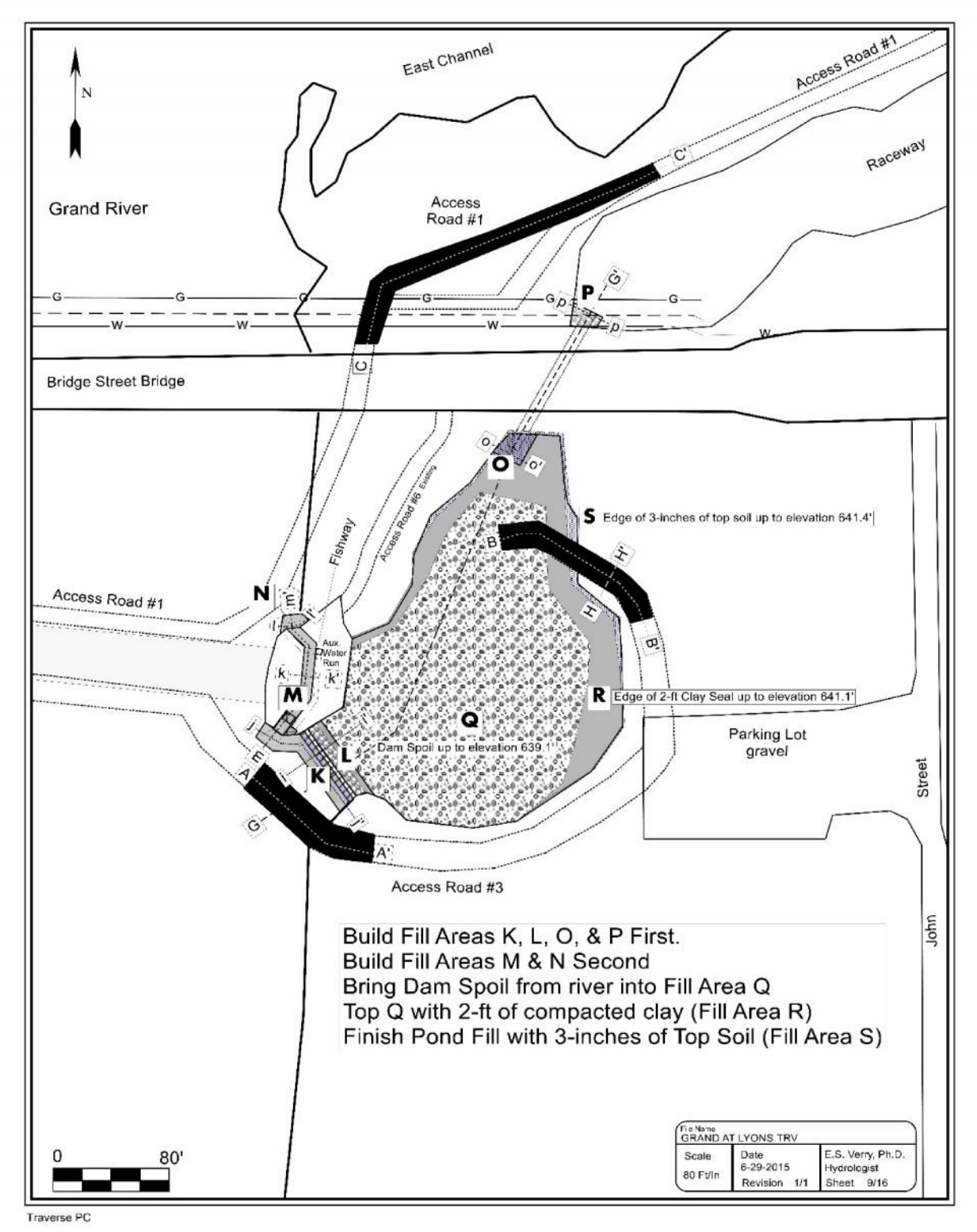


Figure 22. Clay seals (**K**) are placed in front of the raceway gates and the fishway entrance. They are also placed at the fishway exit (**N**) and over the exit culvert from the raceway pond (**O**). Caps of 3-foot stone cover **K** and **N.** The exit of the culvert from the pond at **P** is blocked with MDOT Heavy rip rap. Fill

in the pond is shown with spoil exposed (**Q**), the edge of the 2-foot clay cap (**R**) and the edge of finished topsoil (**S**). Cross section G-G' (in **Figure 28**) shows layer thickness.

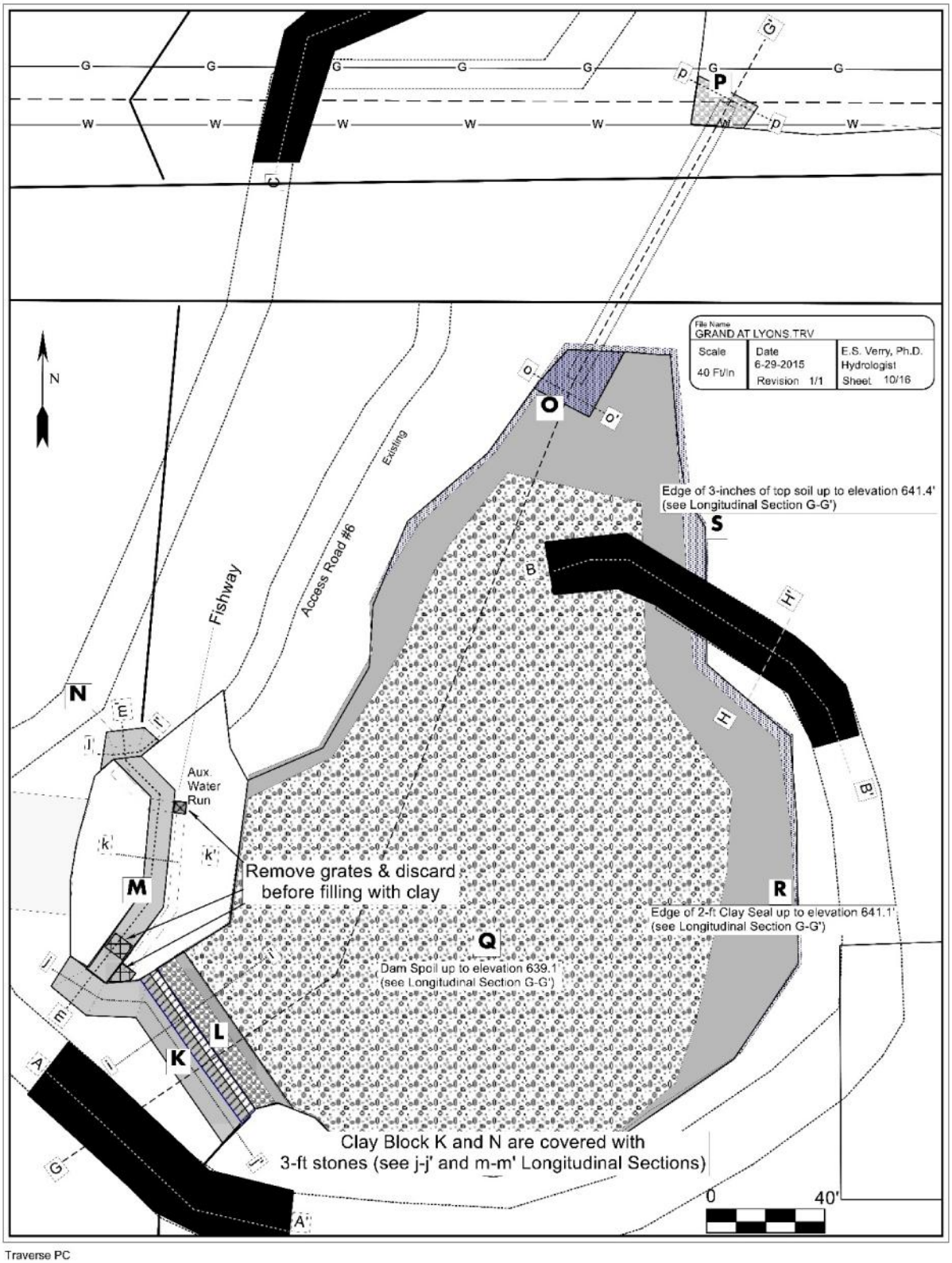


Figure 23. **Figure 22** zoomed-in, note removal of grates before filling the fishway and manhole with clay.

Construct the **K**, **L**, **O**, and **P** fills first. Cross sections i-i', j-j' are shown in **Figures 24 and 25**.

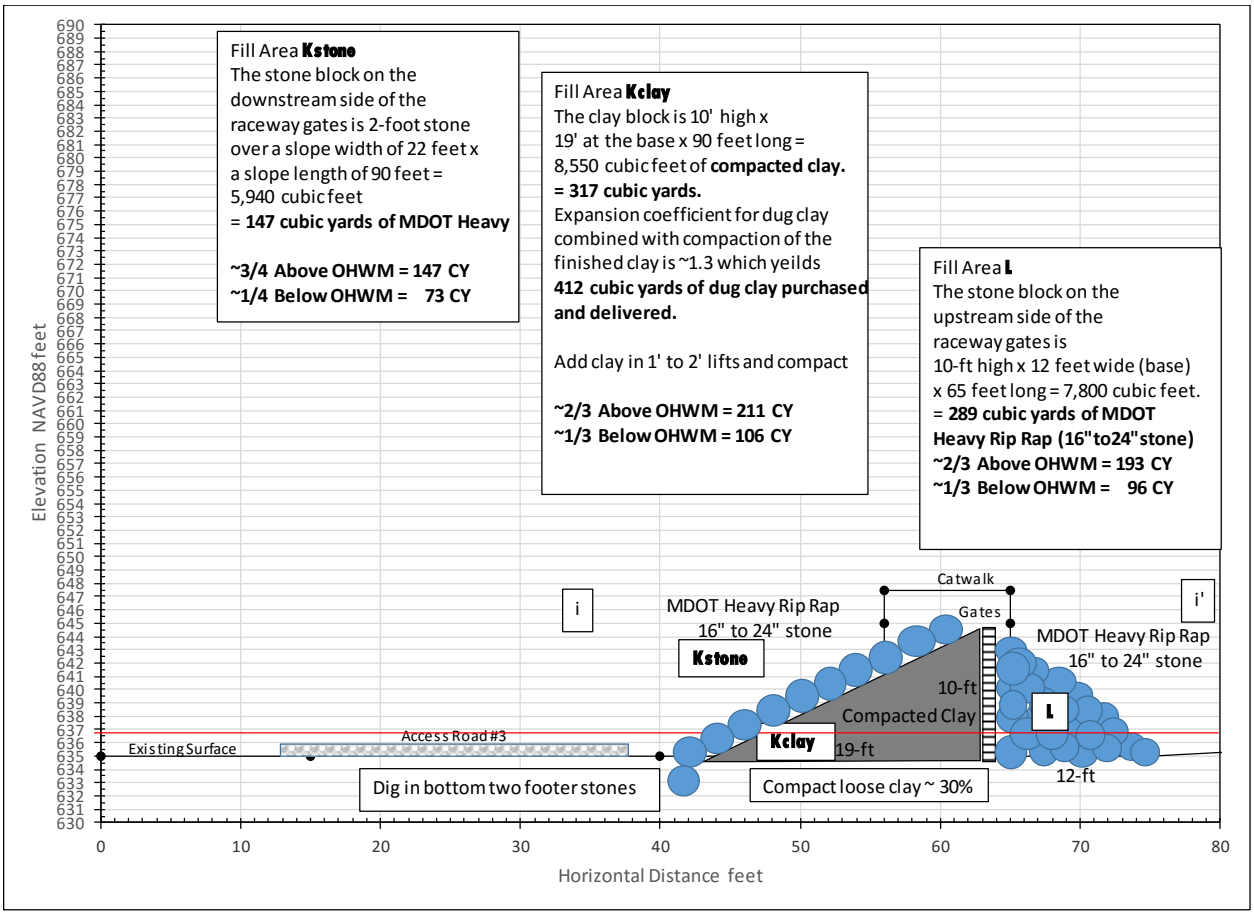


Figure 24. Cross section i-i' of the clay and stone block upstream of the raceway gates and the fishway entrances (**K**) and the MDOT Heavy rip rap downstream of the raceway gates (**L**).

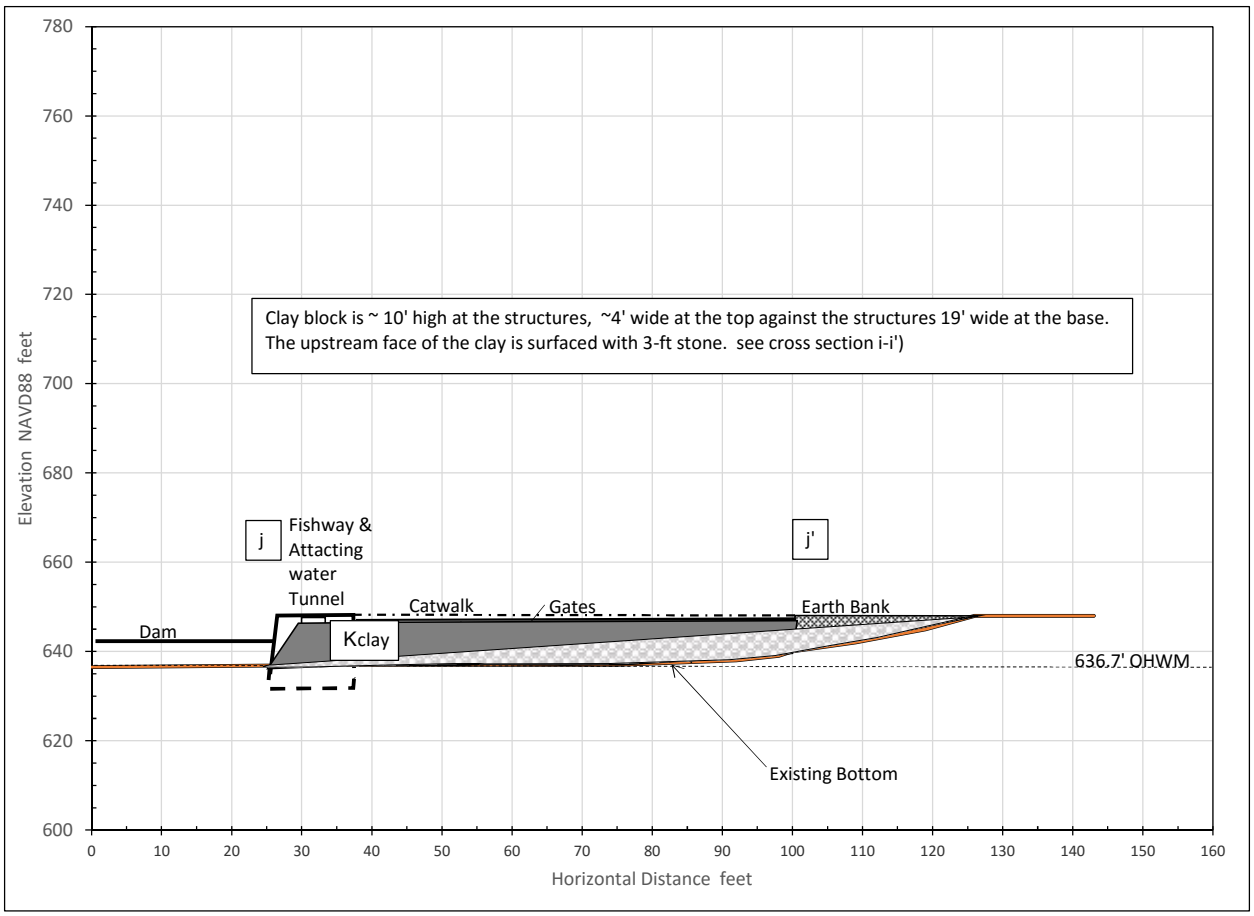


Figure 25. Longitudinal section j-j' clay block in front of the raceway gates and the fishway entrances. The longitudinal section is shown without the 3-foot stone facing on the clay for ice protection (**Fig. 29**).

Figures 26 and 27 show the **c**ross sections o-o' and p-p', respectively, for the clay and stone blocks (**O** & **P**) at the ends of the large culvert under Bridge Street.

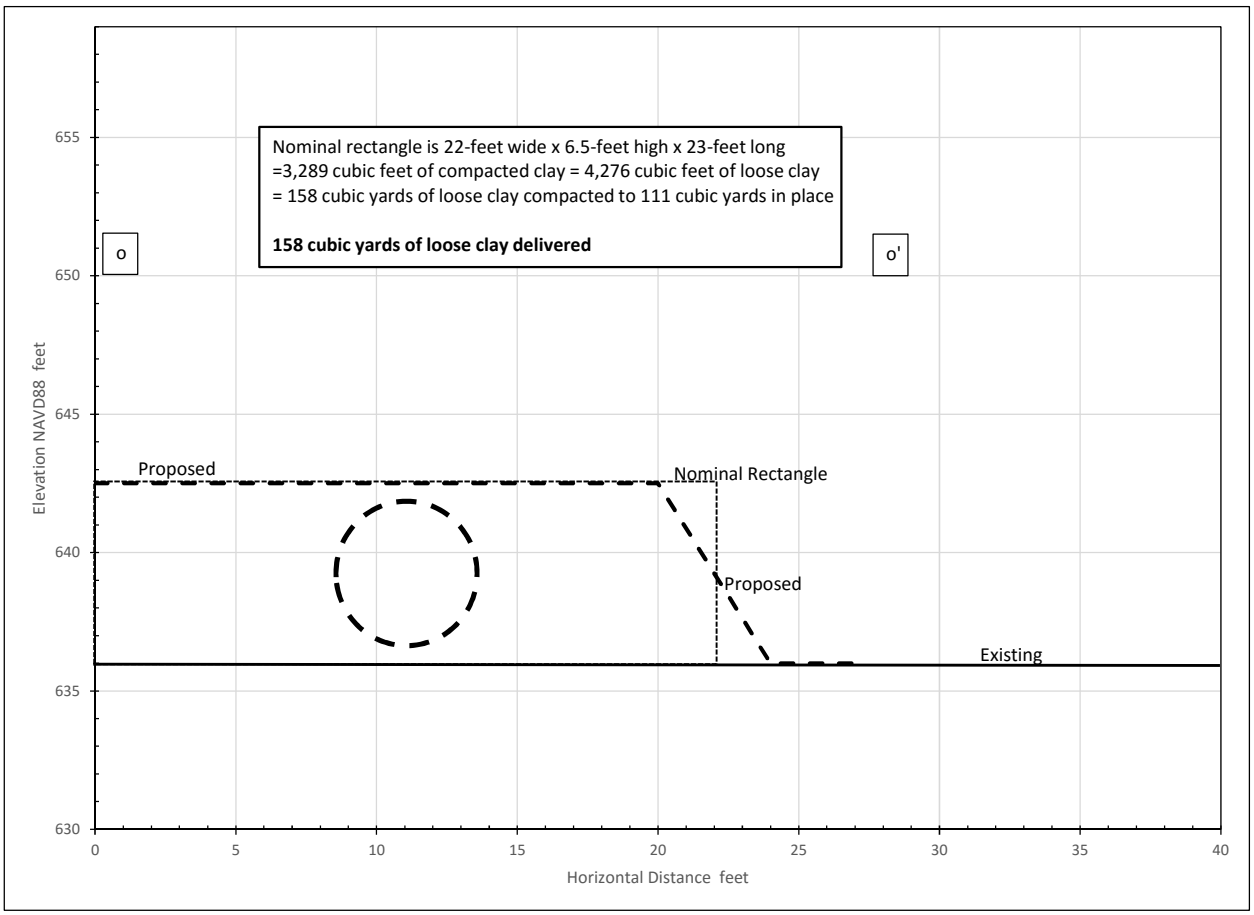


Figure 26. Cross section o-o' showing the clay block at the entrance to the culvert under Bridge Street.

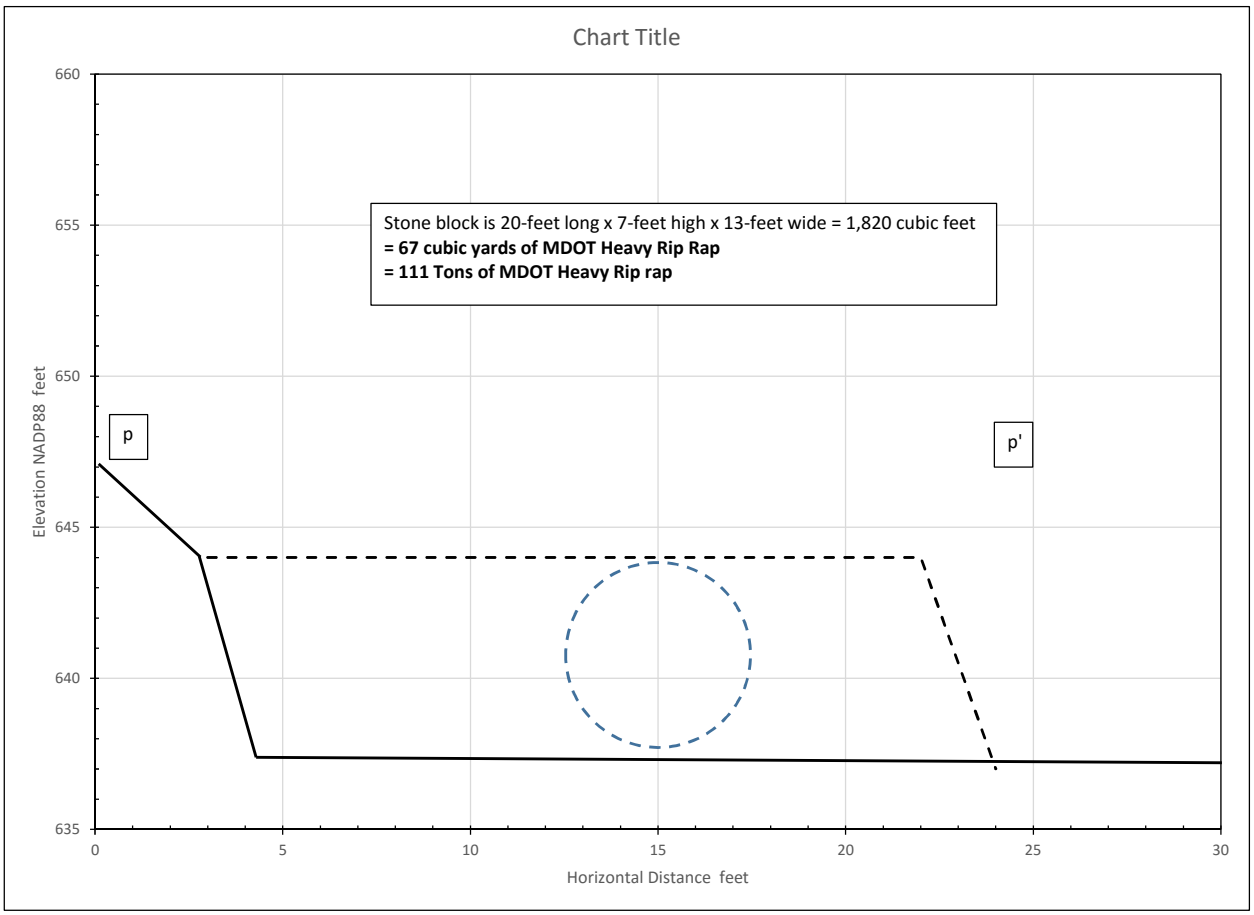


Figure 27. Cross section p-p' showing the stone block at exit of the culvert under Bridge Street.

Now dam spoil material can be moved from its temporary storage into the raceway pond and compacted with machinery as best possible. The remainder of the dam can now be removed with the breaker bar and trucked into the raceway pond for burial.

Figure 28 shows the arrangement of spoil, 2-foot clay cover and top soil in the raceway pond.

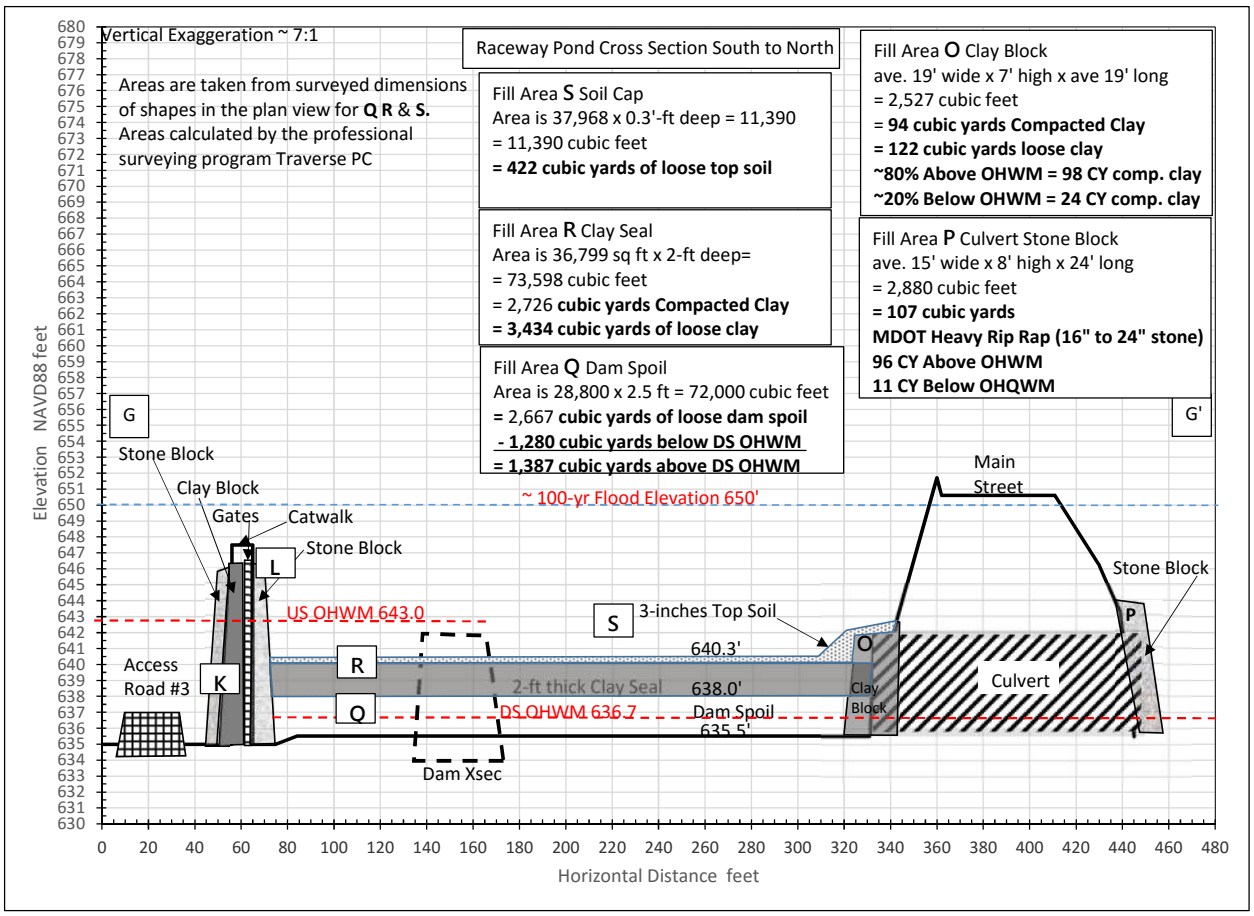


Figure 28. Raceway pond fills **Q, R** and **S,** the gateway blocks (**K** & **L**) and the culvert blocks **O** & **P**.

It is optional at this point to fill the raceway pond (**Q, R & S**) or to complete the clay fills within (**M**) and at the ends of the fishway (**K** and **N**). The cross sections m-m', k-k' and l-l' are shown next in **Figures 29 - 31**. There are multiple **M** fills as the fishway depth varies from its entrance to its exit.

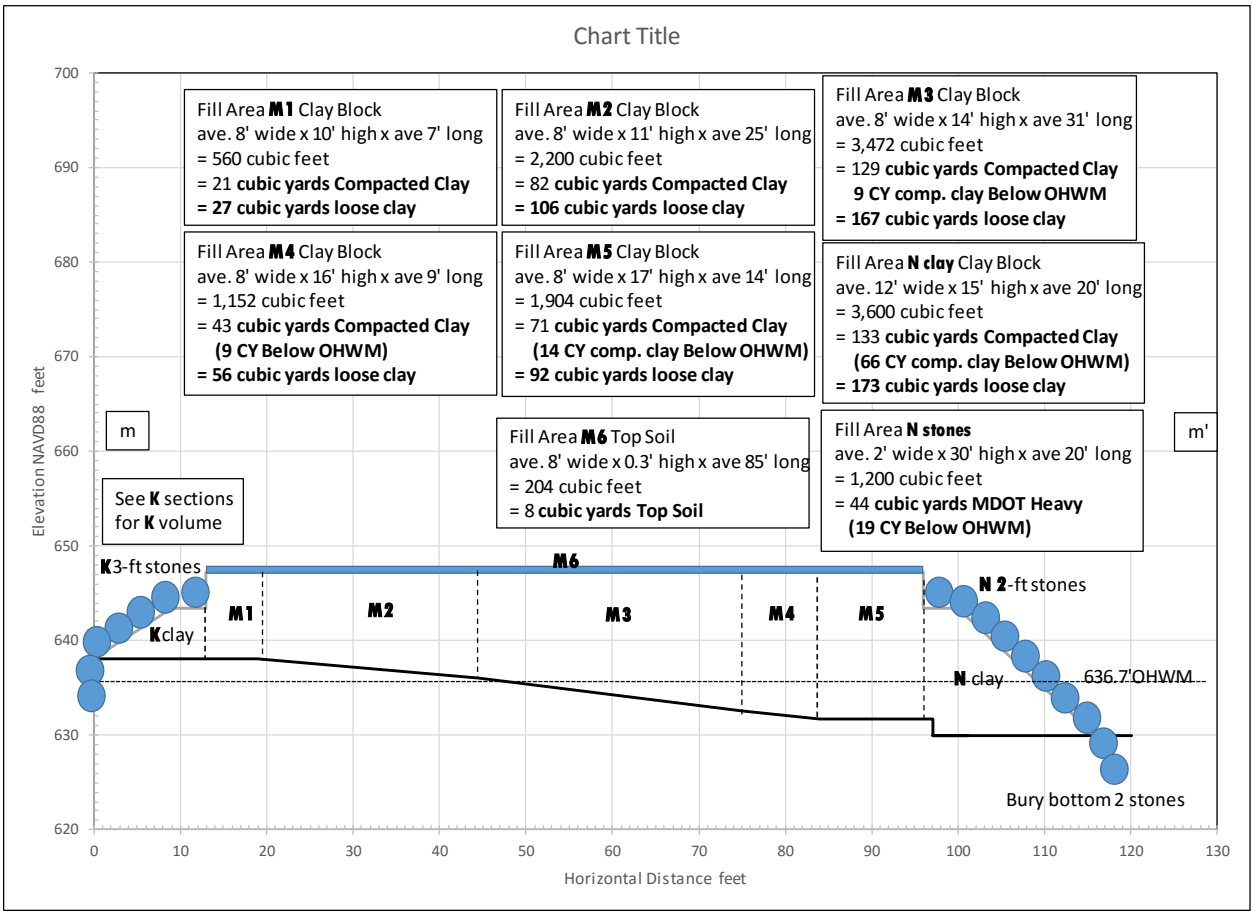


Figure 29. Fishway blocks (**K & N**) and the clay fill within the fishway (**M1 through M5**). Not shown is the clay fill in the square manhole on the east side of the fishway near the last bend, nor is the auxiliary water run entrance (see two of the grate covers in **Figure 23)**. *The manhole (2/3rds of the way down the water run) is 21-feet x 4-feet x 4-feet. This holds a volume of 336 cubic feet = 12 cubic yards of compacted clay or 15.6 cubic yards of loose clay. It is topped with 0.2 cubic yards of top soil. The entrance is 10-feet deep x 9-feet long x 4-feet wide = 360 cubic feet. This holds a volume of 13 cubic yards of compacted clay or 17 cubic yards of loose clay topped with 0.4 cubic yards of top soil.*

BE SURE TO INCLUDE THE AUXILIARY WATER RUN ENTRANCE AND MANHOLE IN THE CLAY SEAL REQUIREMENTS. SEE CAPTION TO FIGURE 34 FOR QUANTITIES AND THE SUMMARY TABLE.

Figures 30 and 31 show cross section k-k' at the middle of the fishway and cross section l-l' at the exit of the fishway.

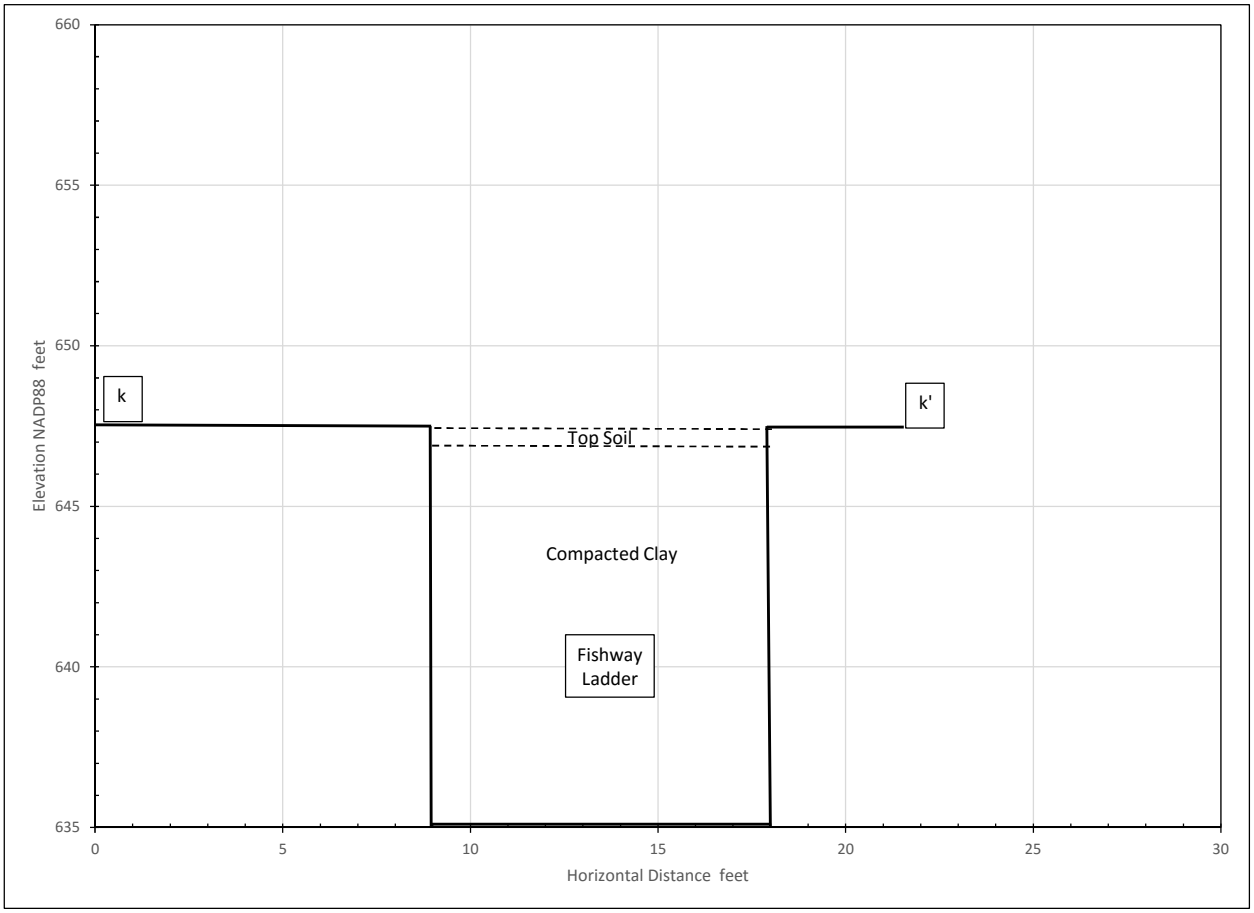


Figure 30. Cross section k-k' in the middle of the fishway ladder.

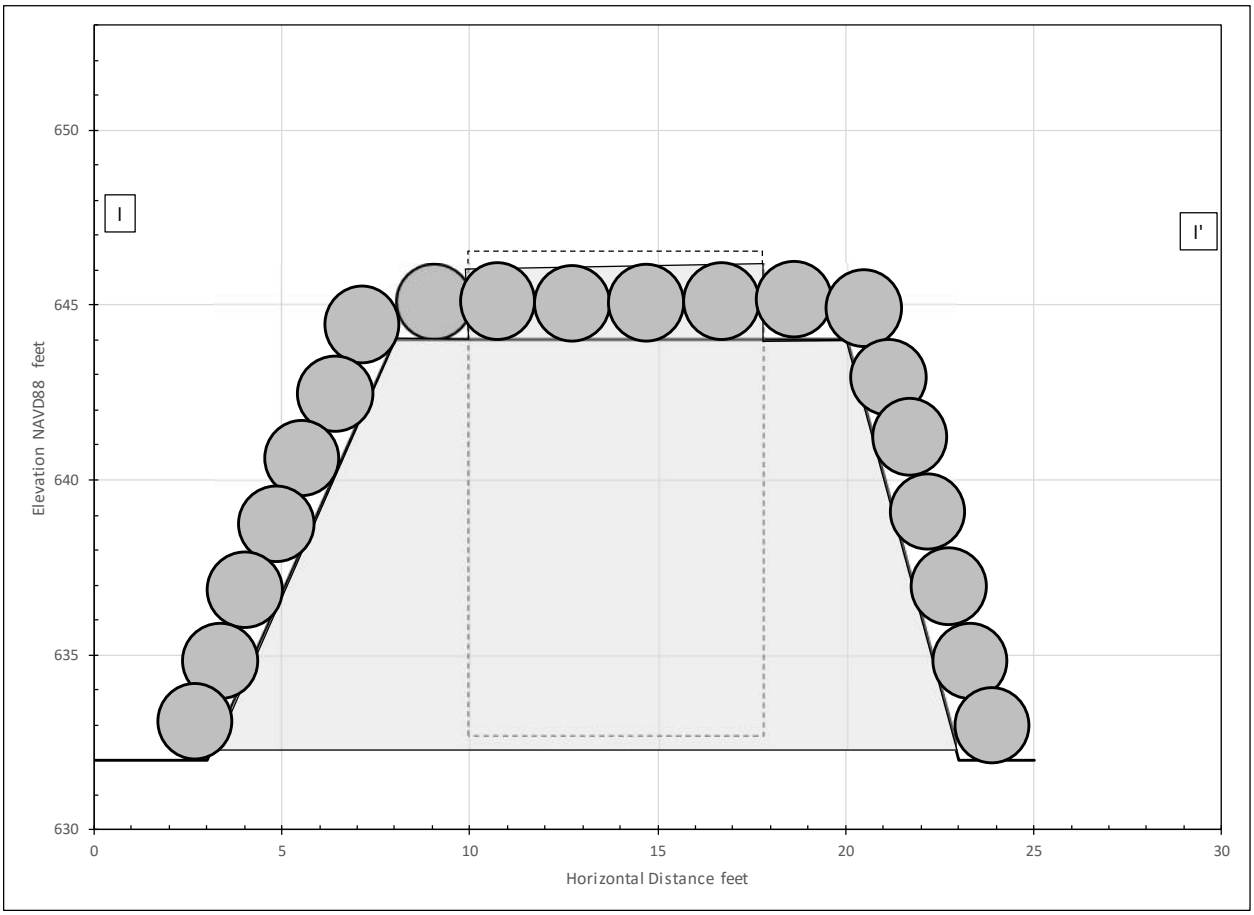


Figure 31. Cross section l-l' at the exit of the fishway ladder.

Complete the removal of the dam including pieces of the west end abutment down to an elevation of 634-feet. The dam concrete at the fishway wall may be cut with a saw about 5-feet west of the wall to ensure the dam can be broken off near the fishway wall without damaging the fishway wall itself. Successive cuts deeper down may be necessary as the surface concrete is removed.

Complete moving all dam spoil into the raceway pond, cap the spoil with two feet of clay and finish with 0.3-feet of top soil (**Figure 28**).

The dam is completely removed down to an elevation of 634-feet and a riffle is built of cobble that was once inside the dam to an elevation of 635.5-feet.

Figure 32 shows the transition between the Toewood Bench and the stone, bankfull bench constructed at the west end of the dam. The figure shows the transition before the Emergency Work was done, but the transition is the same.

Bank Protection and Transition Bankfull Bench at the West End of the Dam

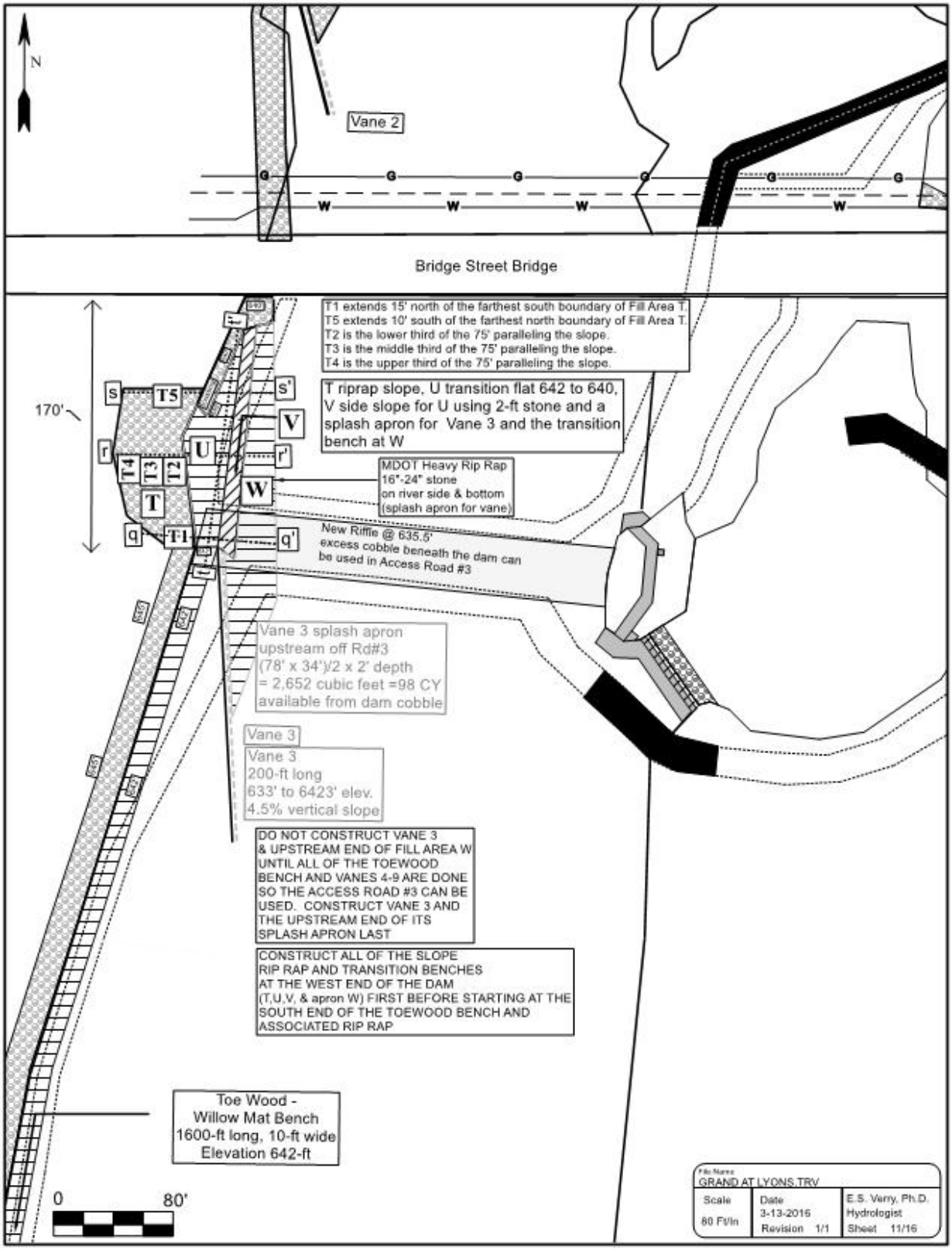


Figure 32. Plan view of bank rip rap and transition bankfull bench at west end of the previous dam.

A longitudinal section parallel to the river (t-t') for the transition bankfull bench is shown in **Figure 33**.

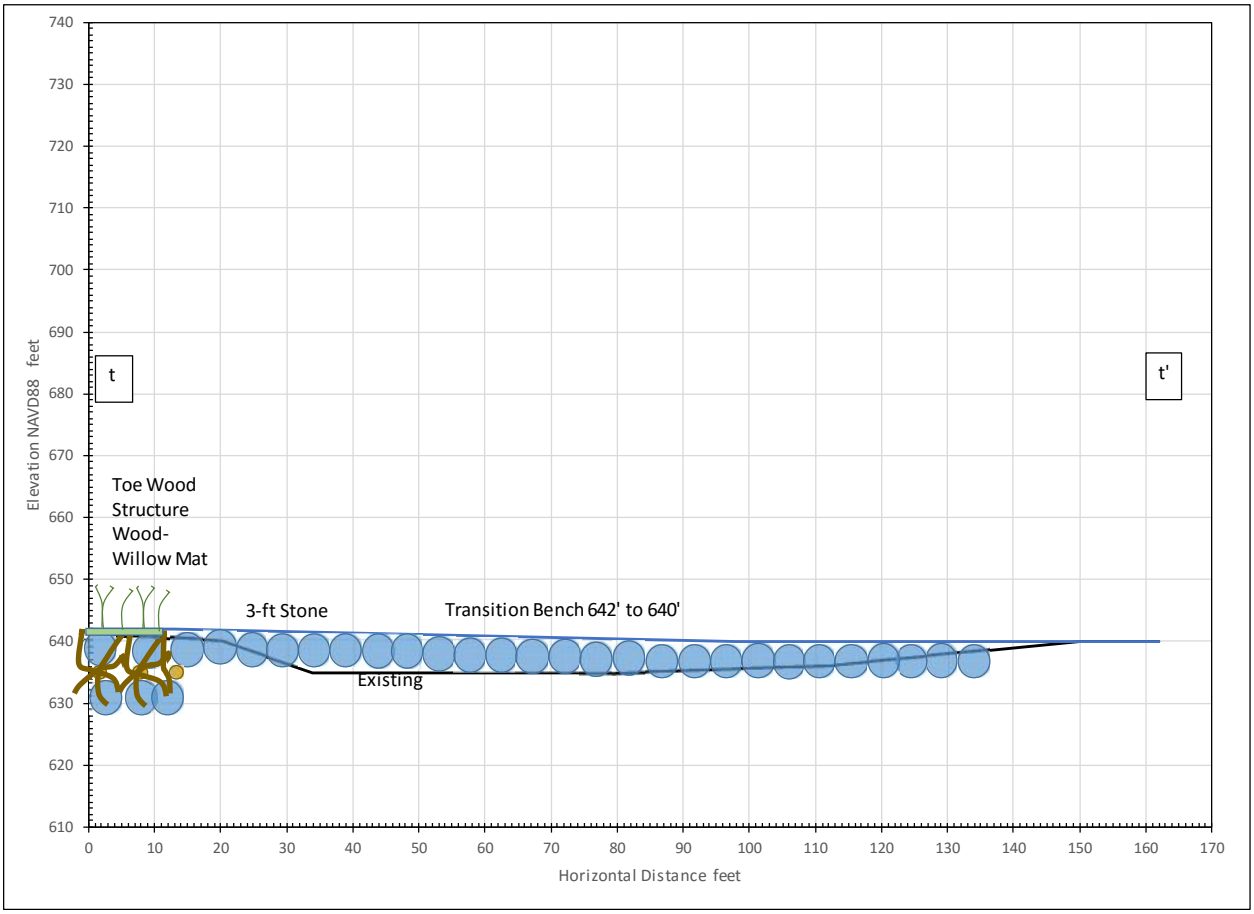


Figure 33. The transition bench elevation joins the toewood bench at an elevation of 643 feet then slopes downward to an elevation 640 feet near the west bridge abutment.

Vane 3 will be left undone until the toewood bench and vanes 4-9 are constructed along the high bank south of the previous dam in order to allow for off-road truck passage along the toe of the high bank.

The Toe Wood Bench, Vanes and Bank Rip Rap South of the Dam

Figure 34 shows the extent of the toe wood bench, the location of vanes 3 through 5 on the toe wood bench, 9, the location of vane 6 through 9 on an existing bank flat and two vane cross sections typical of each condition.

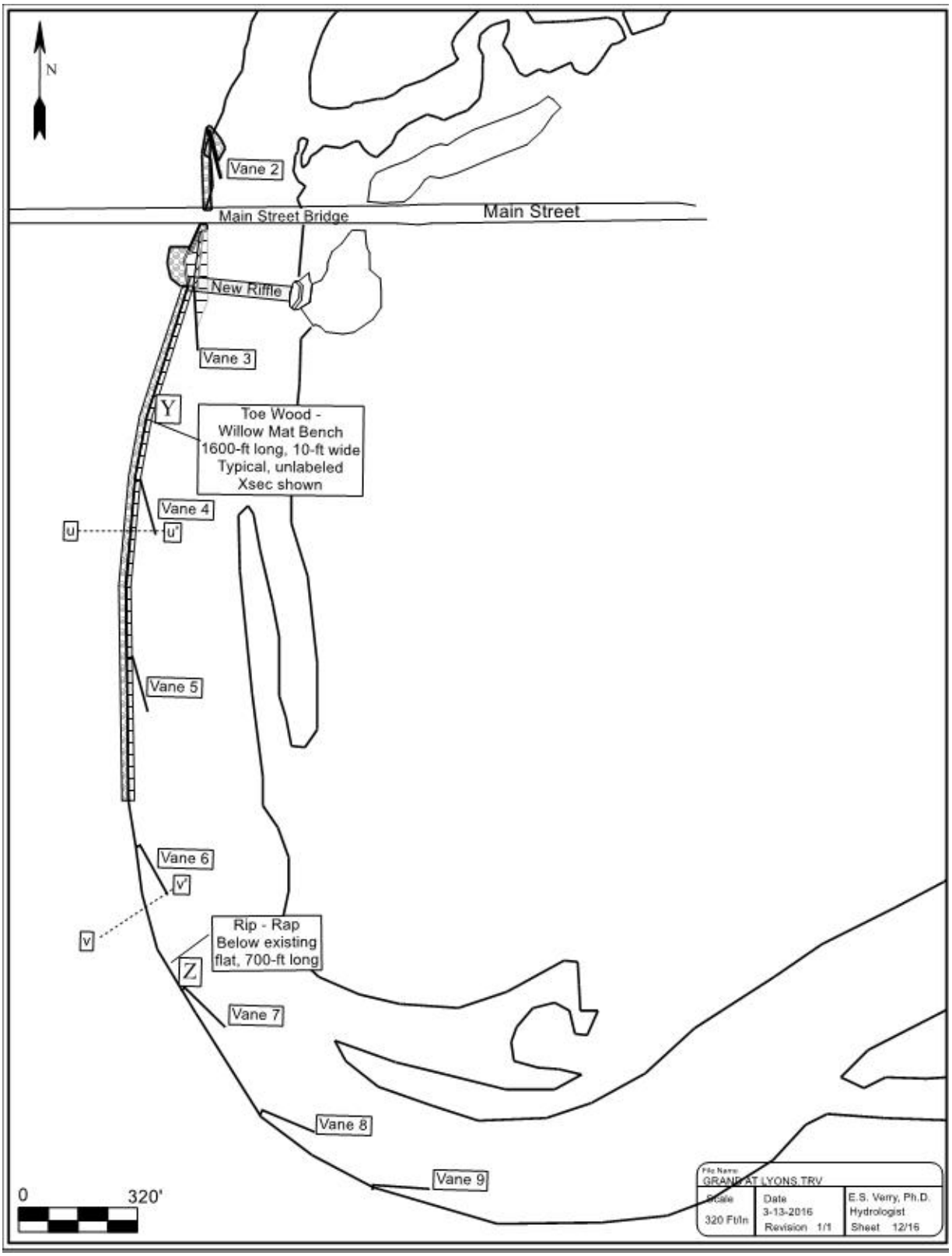


Figure 34. Location of toe wood structure (**Y**) and vanes 3 through 9. Note rip rap (**X**) above the toe wood bench and rip rap (**Z**) below the existing bank flat.

Figures 35 through 36 detail the toe wood bench in plan-view and cross section and the detail of vanes using cross sections u-u' and v-v'.

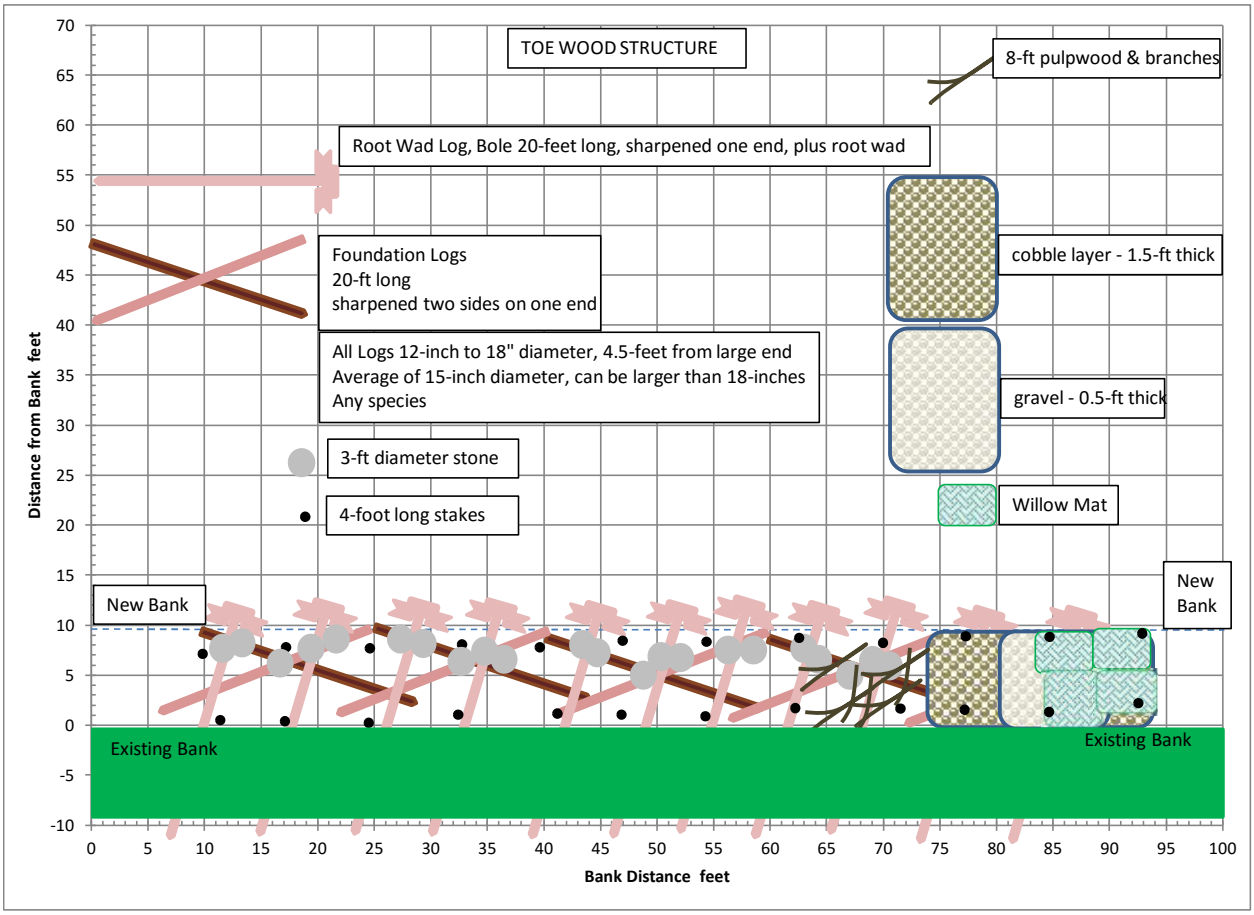


Figure 35. Plan view of the toe wood structure showing progressive layers (left to right). Note, width of toewood bench landward of the root wad is 10- feet.

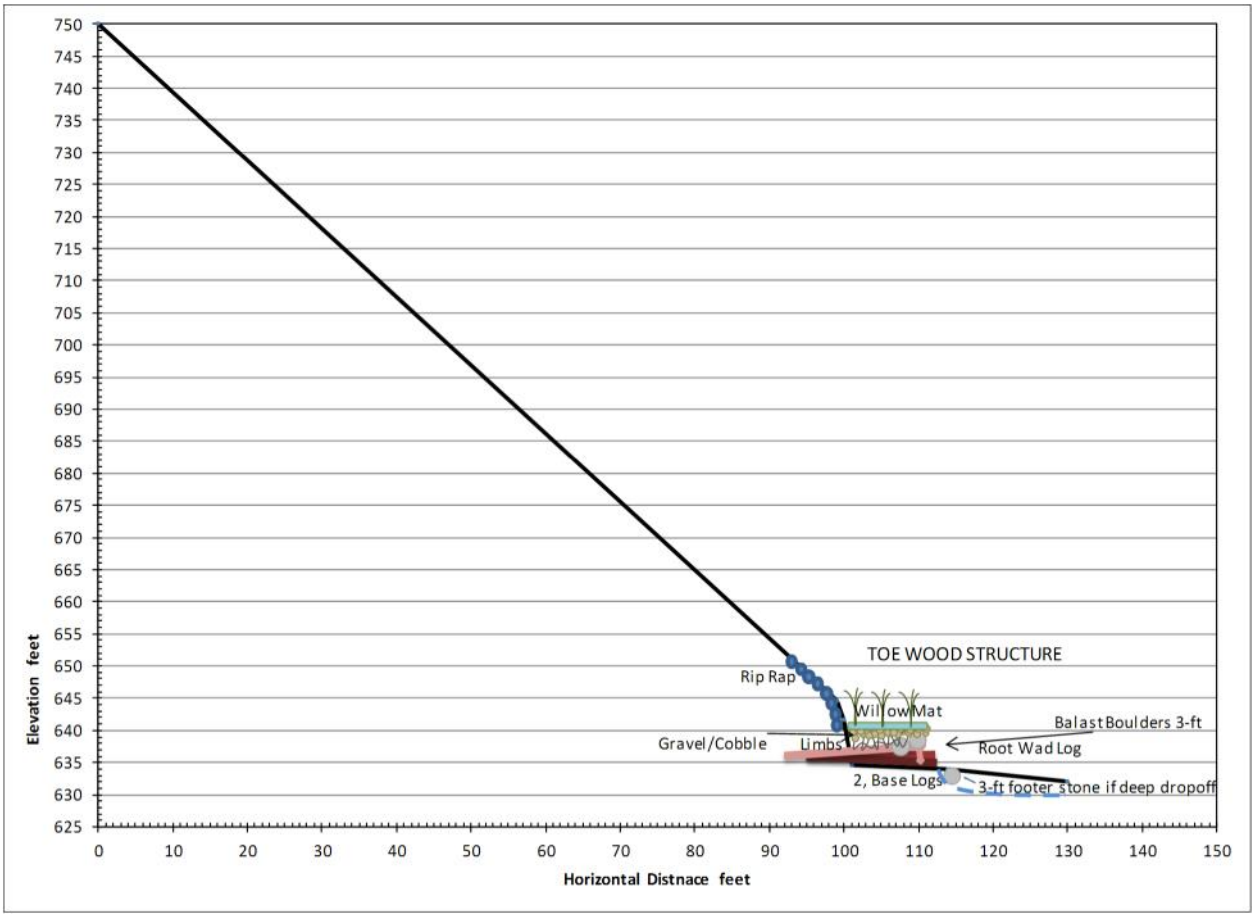


Figure 36. Toe wood structure in (an unlabeled) cross section.

Figures 37 and 38 show cross sections u-u' and v-v' for vanes 4 and 6 at Lyons. **Figures 39 and 40** show typical construction parameters for horizontal and vertical angles for all vanes on river left.

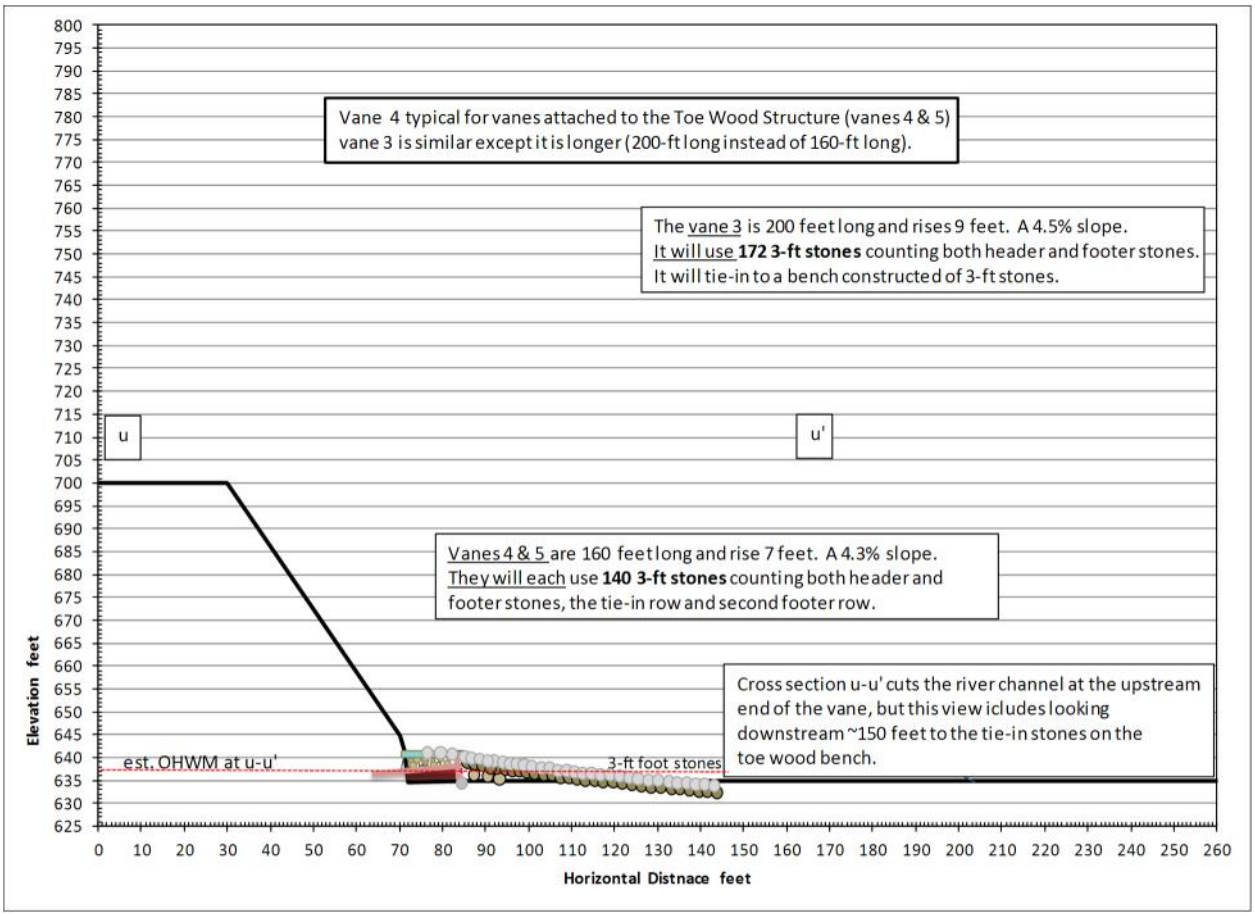


Figure 37. Cross section u-u' showing vane 4 attached to the toe wood structure. This is typical for vanes 4 and 5.

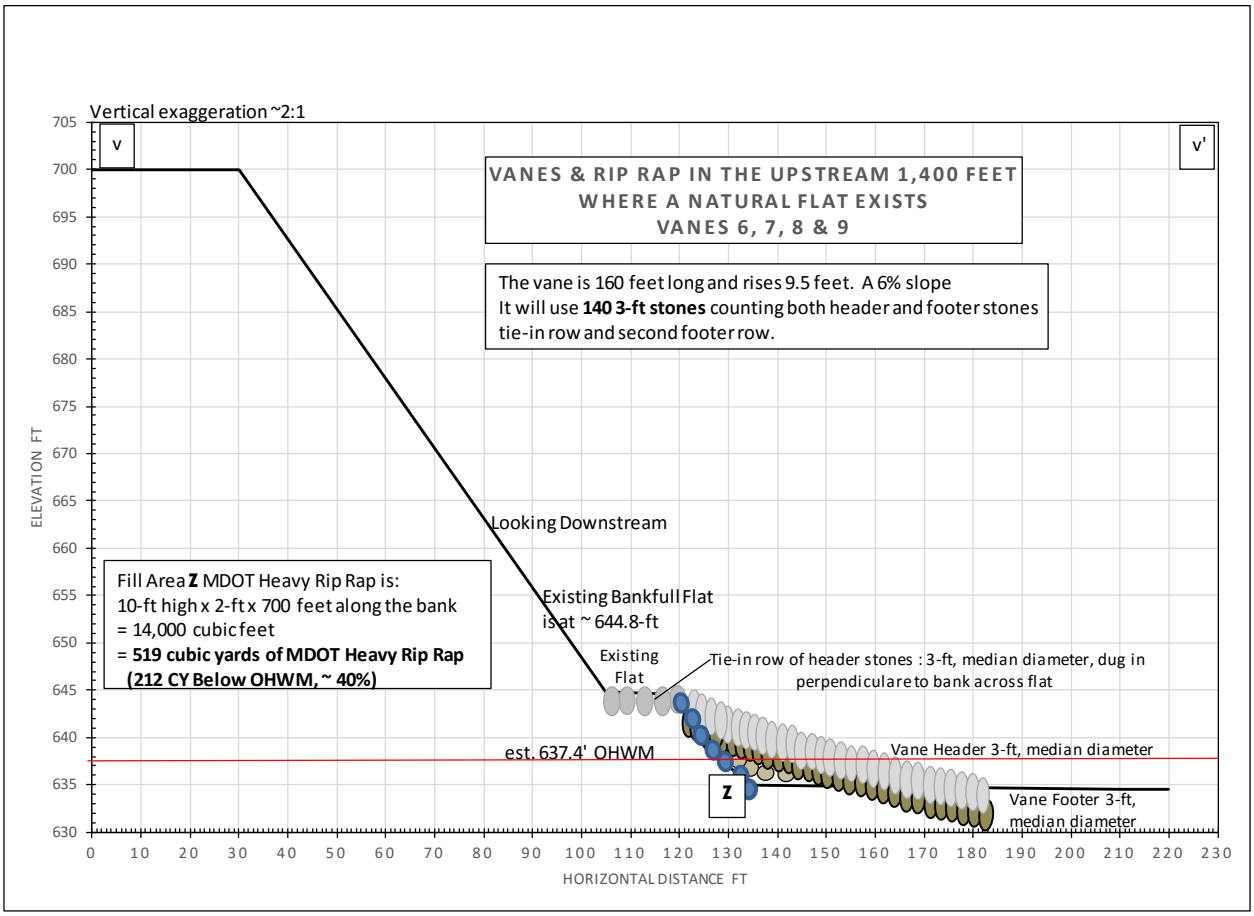


Figure 38. Cross section u-u' showing vane 6 attached to an existing bank flat. This is typical for vanes 6 through 9.

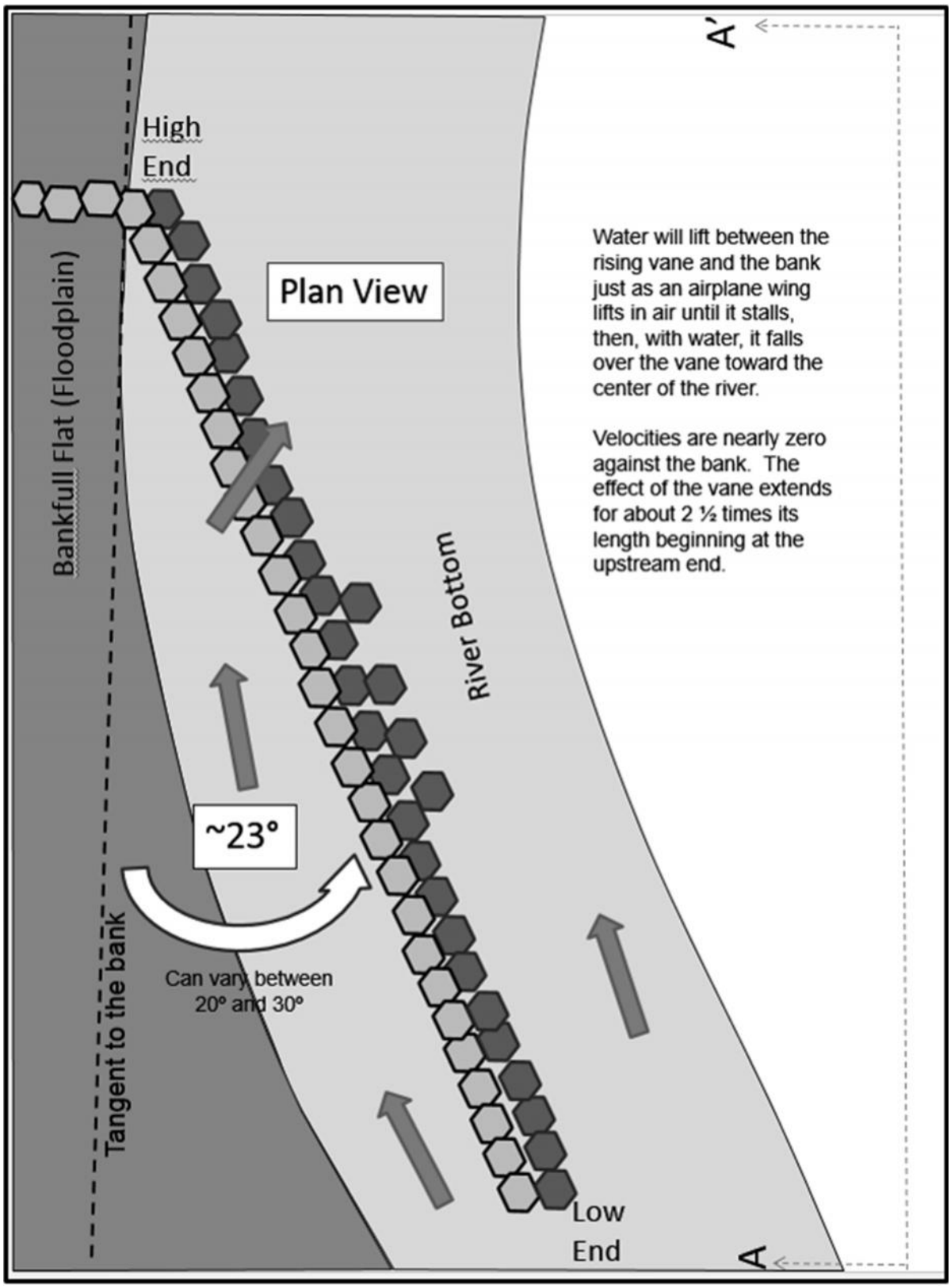


Figure 39. Plan view showing construction angle of all vanes on river left. See cross section A-A' in **Figure 40**.

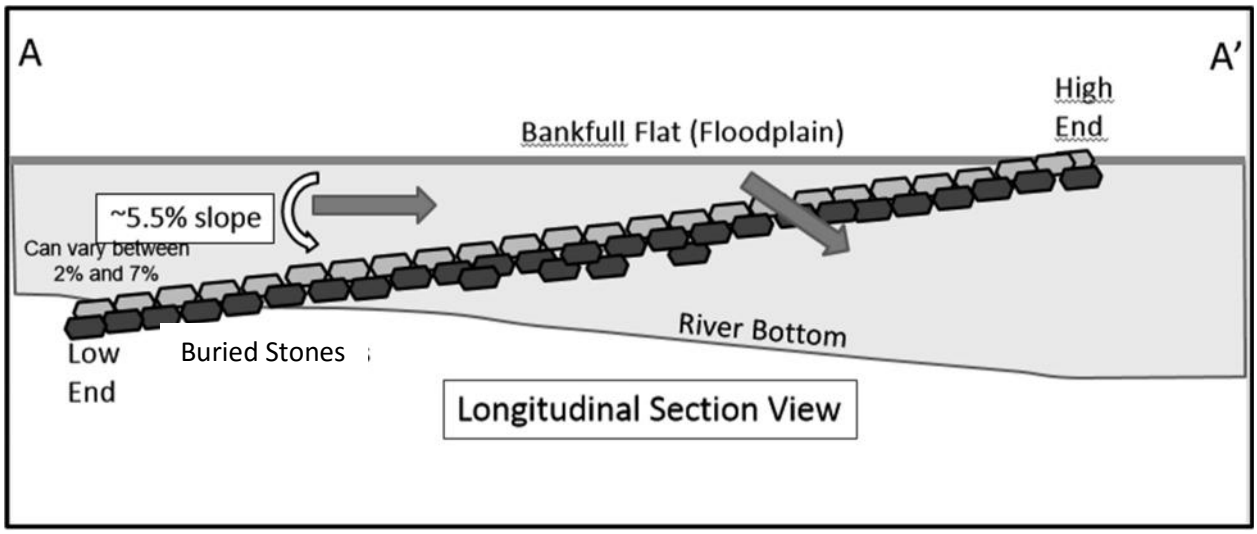


Figure 40. Cross section A-A' showing vertical construction angle range for all vanes on river left.

Cut and Fill quantities are summarized in **Table 3**. Disregard items pertaining to Hazel Devore Island and the East Channel.

Table 3a. Cut and Fill Quantities for the Access Roads, Raceway Pond Fill and Fishway Fill.

Cut or Fill	Pg #/Fig# or Table #	Xsec	LongSec	Length	Width	Depth	Xsec Aea			Fill Above OHWM	Fill Below OHWM	Cut Above OHWM	Cut Below OHWM	
Description	Label	Label	Label	ft	ft	ft	sq ft	Cubic Ft	CY	CY	CY	CY		Notes
Cut J Exist. Stone at Raceway Gates	3,4/3,4	a-a'	b-b'	60	27	10	122	7,290	256			**175**	**81**	
Fill Area C steep part of Access Road #1	17,18,19/5,11,12	H-H'	C-C'	245	12	1		2,940	109	109				Essentially packed to existing surface
Fill Area F steep part of Access Road #2	17,20/5,13	H-H'	F-F'	65	12	1		780	29	29				Essentially packed to existing surface
Fill Area G steep part of Access Road #2	17,20/5,13	H-H'	F-F'	30	12	2.5		900	33	33	25			Essentially packed to existing surface
Fill Area D steep part of Access Road #4	17,21/5,14	H-H'	D-D'	130	12	1		1,560	58	58				Essentially packed to existing surface
Fill Area E steep part of Access Road #5	17,22/5,15	H-H'	E-E'	70	12	1		840	31		31			
Sand over sidewalk & sewer	17/5	sht 4/16		45	12	1		540	20	20				Removed when job is completed
Some (?)MDOT Heavy along dam base	23/16	NA							3		5			Filling a hole in channel bottom no effect on flooding
Fill Area H deep hole at west end of dam	23,25,25/16,17,18	c-c'	d-d'	40	20	5	200	4,000	148		148			Below OHWM
Fill Area I Rip Rap North of W Brige Abut.	23,26/16,19	e-e'	f-f'	200	25	2		10,000	370	555				Landward of the channel proper on existing slope
Fill Area J Vane 2 Splash Apron	23,26/16,19	e-e'	f-f'	85	26	3		6,630	246		246			
Fill Area A steep part of Access Road #3	32-34/23-26	g-g'	h-h'	100	25	3.4		8,500	315		45			315 - existing 270 = 45
Fill Area B steep part of Access Road #3	33,36,37/23,26,27	H-H'	B-B'	90	12	1		1,080	40	40				Essentially packed to existing surface
								0	0					
Fill Area K Clay		i-i'	j-j'	90	19	10		8,550	317	211	106			Less portion below OHWM 636.7' subtracted
Fill Area K Stone Block		i-i'	j-j'	90	22	2		3,960	147	147	73			Less portion below OHWM 636.7' subtracted
Fill Area L Stone Block		i-i'	j-j'	65	12	10		7,800	289	193	96			Inside isolated raceway pond
Fill Area O Clay raceway culv. Entr.		o-o'		23	22	6.5		3,289	122	98	24			Inside isolated raceway pond
Fill Area P Stone raceway culvert exit		p-p'		20	13	7		1,820	107	96	11			Inside isolated raceway
Cut - Dam spoil removed	28/Table 3											743	1,115	
Dam spoil expanded in raceway pond	28/Table 3		G-G'						2,415	1,135				Less portion below OHWM (2,415)-1,280=1,135 CY
Fill Area R Clay cap over raceway spoil	37,38,43/27,28,33		G-G'			2	36,799	73,598	2,726	2,726				Inside isolated raceway pond
Fill Area S Top Soil over raceway clay cap	37,38,43/27,28,33		G-G'			0.3	36,968	11,090	411	411				Inside isolated raceway pond
Fill Area M1 Clay Block	44/34		m-m'	10	8	7	56	560	21	21				Inside isolated fishway
Fill Area M2 Clay Block	44/34		m-m'	11	8	25	200	2,200	81	81				Inside isolated fishway
Fill Area M3 Clay Block	44,45/34,35	k-k'	m-m'	14	8	31	248	3,472	129	129				Inside isolated fishway
Fill Area M4 Clay Block	44/34		m-m'	16	8	9	72	1,152	43	34	9			Inside isolated fishway
Fill Area M5 Clay Block	44/34		m-m'	17	8	14	112	1,904	71	57	14			Inside isolated fishway
Fill Area M6 Top SoilClay Block	44,45/34,35		m-m'	85	8	0.3	2	204	8	8				Inside isolated fishway
Fill - Auxiliary Water Run Entrance	38/28			10	9	4	36	360	13	13				Inside isolated fishway
Fill - Auxiliary Water Run Mnahole	38/28			21	4	4	16	336	12	10	2			Inside isolated fishway
Fill Area N Clay Block	44,46/34,36	m-m'	l-l'	20	15	12	180	3,600	133	67	66			
Fill Area N Stones	44,46/34,36	m-m'	l-l'	20	30	2	60	1,200	44	20	24			

Table 3b. Fill Quantities for West End Rip Rap, Toe Wood Structure, Main & East Channel Rip Rap.

Cut or Fill Description	Pg #/Fig# or Table # Label	Xsec Label	LongSec Label	Length ft	Width ft	Depth ft	Xsec Aea sq ft	Cubic Ft	CY	Fill Above OHWM CY	Fill Below OHWM CY	Cut Above OHWM CY	Cut Below OHWM	Notes
Fill Area T1	47-51/37,38	q-q'		15	40	2	80	1,200	44	44				Landward of the channel proper on existing slope
Fill Area T2	47,49/37,39	r-r'		75	21	10	210	15,750	583	583				Landward of the channel proper on existing slope
Fill Area T3	47,49/37,39	r-r'		75	21	7	147	11,025	408	408				Landward of the channel proper on existing slope
Fill Area T4	47,49/37,39	r-r'		75	13	2	26	1,950	72	72				Landward of the channel proper on existing slope
Fill Area T5	47,50/37,40	s-s'		10	28	2	56	560	21	21				Landward of the channel proper on existing slope
Fill Area U1	47,48/37,38	q-q'		15	10	6	60	900	33	32	1			Restored Bankfull Bench
Fill Area U2	47,49/37,39	r-r'		75	23	6	138	10,350	383	383				Restored Bankfull Bench
Fill Area U3	47,50/37,40	s-s'		50	12	2	24	1,200	44	44				Restored Bankfull Bench
Fill Area V	47/48/37,38	q-q'		225	10	4.5	45	10,125	375	187	188			
Fill Area W	47/48/37,38	q-q'		168	29	2	58	9,744	361		361			Below 636.7' OHWM
Fill Area Y Toe Wood Willow Mat Bench	53-55/42-44	v-v'		1600	15	7	105	168,000	6,222	4,144	2,078			Landward of the channel proper
Fill Area Z Rip Rap Below Existing Flat	53,57/42,46	v-v'		700	11	2	22	15,400	570	368	212			Pushed into existing soil
Fill Area AA Finish Volume	60,61/49,50	w-w'							4,753					Restores Original Island Mass
Fill Area AA East Channel Top Soil	60,61/49,50	w-w'		230	95	0.3	29	6,555	243	243				Restores Original Island Mass
Volume of BB Expanded & Compacted	60,61/49,50	w-w'							1,487					Restores Original Island Mass
Fill Area AA MDOT Heavy Rip Rap	60,61/49,50	w-w'							3,023	1,122	1,901			Restores Original Island Mass
Cut Area BB Restored East Channel	60,61/49,50	w-w'		100			365	36,500	1,352			676	676	Restores channel to normal width and depth
Fill Area CC East Channel Rip Rap	60,62/49,51	x-x'		175	2	7.5	15	2,625	97	77	20			
Fill Area DD East Channel Rip Rap	64,65/53,54	y-y'		40	14	2	28	1,120	41	29	123			
Fill Area EE Main Channel Rip Rap	66-68/55-57	z-z'	& aa-aa'	495	36	3		53,460	2,367	1,420	947			Overwide section of river, does not affect flooding

Table 3c. Fill quantities for the vanes.

Cut or Fill	Pg #/Fig# or Table #	Xsec	LongSec	Length	Width	Depth	Xsec Aea			Fill Above OHWM	Fill Below OHWM	Cut Above OHWM	Cut Below OHWM	
Description	Label	Label	Label	ft	ft	ft	sq ft	Cubic Ft	CY	CY	CY	CY		Notes
Vane 2 Header Row	23,26,27/16,19,20	e-e'		160	3	3		1,440	53	21	32			ds of Dam ~60% of vane is above OHWM see Fig 20
Vane 2 Footer Row	23,26,27/16,19,21	e-e'		160	3	3		1,440	53	21	32			ds of Dam ~60% of vane is above OHWM see Fig 20
Vane 3 Header Row	47/37			200	3	3		1,800	67	34	33			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 3 Footer Row	47/37			200	3	3		1,800	67	34	33			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 4 Header Row	53,56/42,45	u-u'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 4 Footer Row	53,56/42,45	u-u'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 5 Header Row	53,56/42,45	u-u'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 5 Footer Row	53,56/42,45	u-u'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 6 Header Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 6 Footer Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 7 Header Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 7Footer Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 8 Header Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 8 Footer Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 9 Header Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane9 Footer Row	53,57/42,46-48	v-v'		160	3	3		1,440	53	26	27			us of Dam ~ 50% of vane is above OHWM se Fig 45
Vane 10 Header Row	64/53	typical		100	3	3		900	33	13	20			ds of Dam ~60% of vane is above OHWM see Fig 20
Vane 10 Footer Row	64/53	typical		100	3	3		900	33	13	20			ds of Dam ~60% of vane is above OHWM see Fig 20
Vane 11 Header Row	58,59,66/47,48,55	typical		126	3	3		1,134	42	17	25			ds of Dam ~60% of vane is above OHWM see Fig 20
Vane 11 Footer Row	58,59,66/47,48,55	typical		126	3	3		1,134	42	17	25			ds of Dam ~60% of vane is above OHWM see Fig 20
TOTAL										**17,263**	**7,523**	**1,594**	**757**	