Highland Park Dam Mitigation and Riparian Enhancement Project for Swan Creek

Aaron Steber
Scott Dierks, PE

August 25, 2008
Toledo, Ohio

Partners for Clean Streams

JFNew

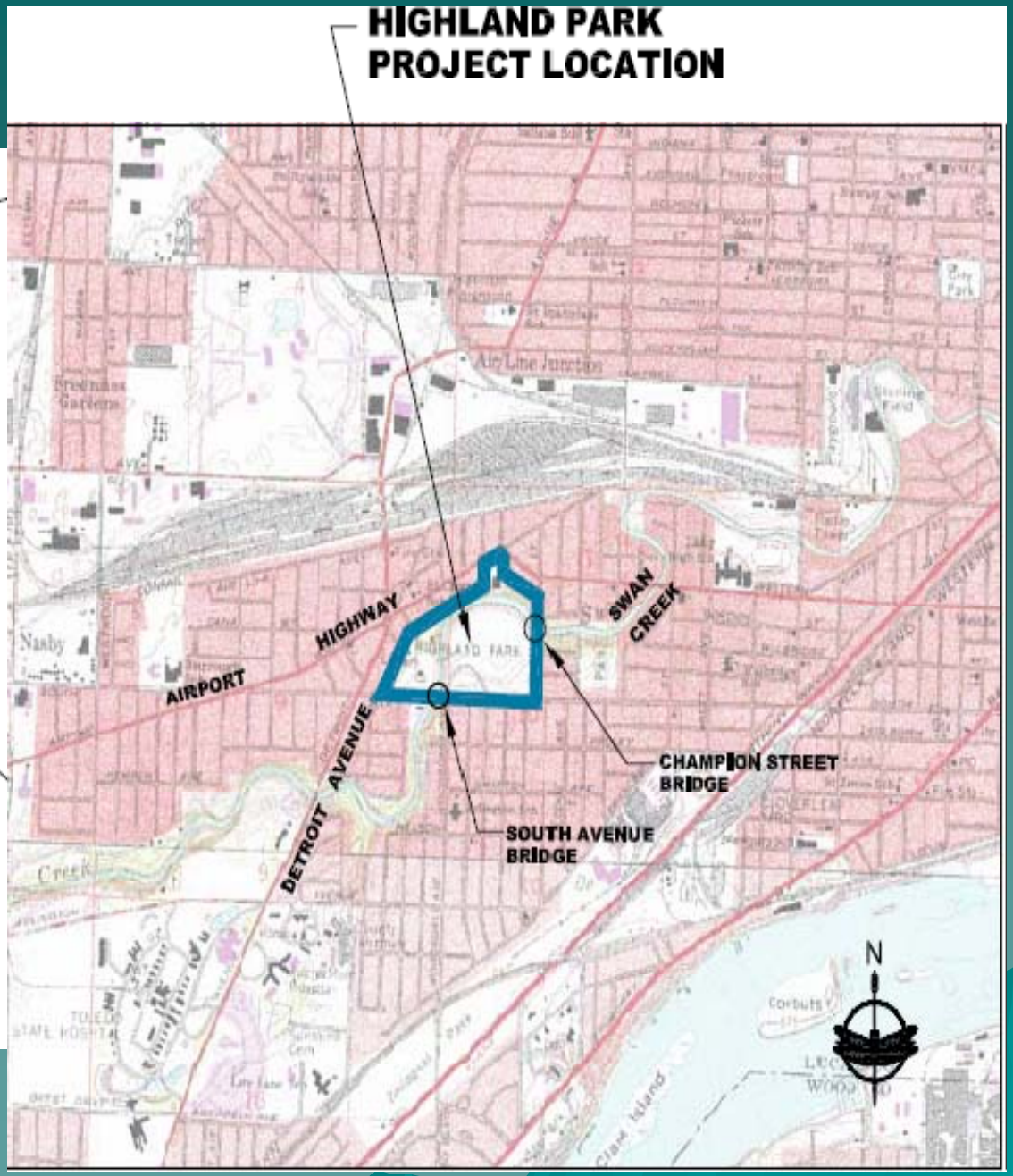
Acknowledgments

- Matt Horvat, Toledo Metropolitan Area Council of Governments
- Cherie Blair, Ohio EPA
- Pat Lawrence, Partners for Clean Streams (Maumee RAP), University of Toledo
- Kris Patterson, Partners for Clean Streams
- Dave Derrick, Army Corps of Engineers
- Dave Hails, Ecological Restoration, Inc.
- Patrick Judd, Conservation Design Forum

Project Overview

- Partners for Clean Streams, a non-profit organization in Toledo, OH, hired JFNew to design and build a dam mitigation and riparian enhancement project in Highland Park in Toledo, OH
- Highland Park is located along Swan Creek and adjacent to Highland Park Dam, an existing low-head dam
- The proposed project includes a series of rock dams downstream of the dam which will effectively “lift up” the downstream bed to meet the existing dam


TOLEDO
FULTON
WILLIAMS
DEFIANCE
HENRY
WOOD
OTTAWA
SANDUSKY
ERIE
LORAIN
CUYAHOGA
LAKE
GEAUGA
ASHTABULA
PAULDING
PUTNAM
HANCOCK
SENECA
HURON
MEDINA
SUMMIT
PORTAGE
TRUMBULL
VAN WERT
ALLEN
WYANDOT
CRAWFORD
RICHLAND
ASHLAND
WAYNE
STARK
MAHONING
COLUMBIANA
MERCER
AUGLAIZE
HARDIN
MARION
HOLMES
CARROLL
SHELBY
LOGAN
UNION
DELAWARE
MORROW
KNOX
COSHOCTON
TUSCARAWAS
HARRISON
JEFFERSON
DARKE
MIAMI
CHAMPAIGN
CLARK
MADISON
FRANKLIN
LICKING
MUSKINGUM
GUERNSEY
BELMONT
PREBLE
MONTGOMERY
GREENE
FAYETTE
PICKAWAY
FAIRFIELD
PERRY
MORGAN
NOBLE
MONROE
BUTLER
WARREN
CLINTON
ROSS
HOCKING
ATHENS
WASHINGTON
HAMILTON
CLERMONT
HIGHLAND
PIKE
VINTON
MEIGS
BROWN
ADAMS
SCIOTO
JACKSON
GALLIA
LAWRENCE

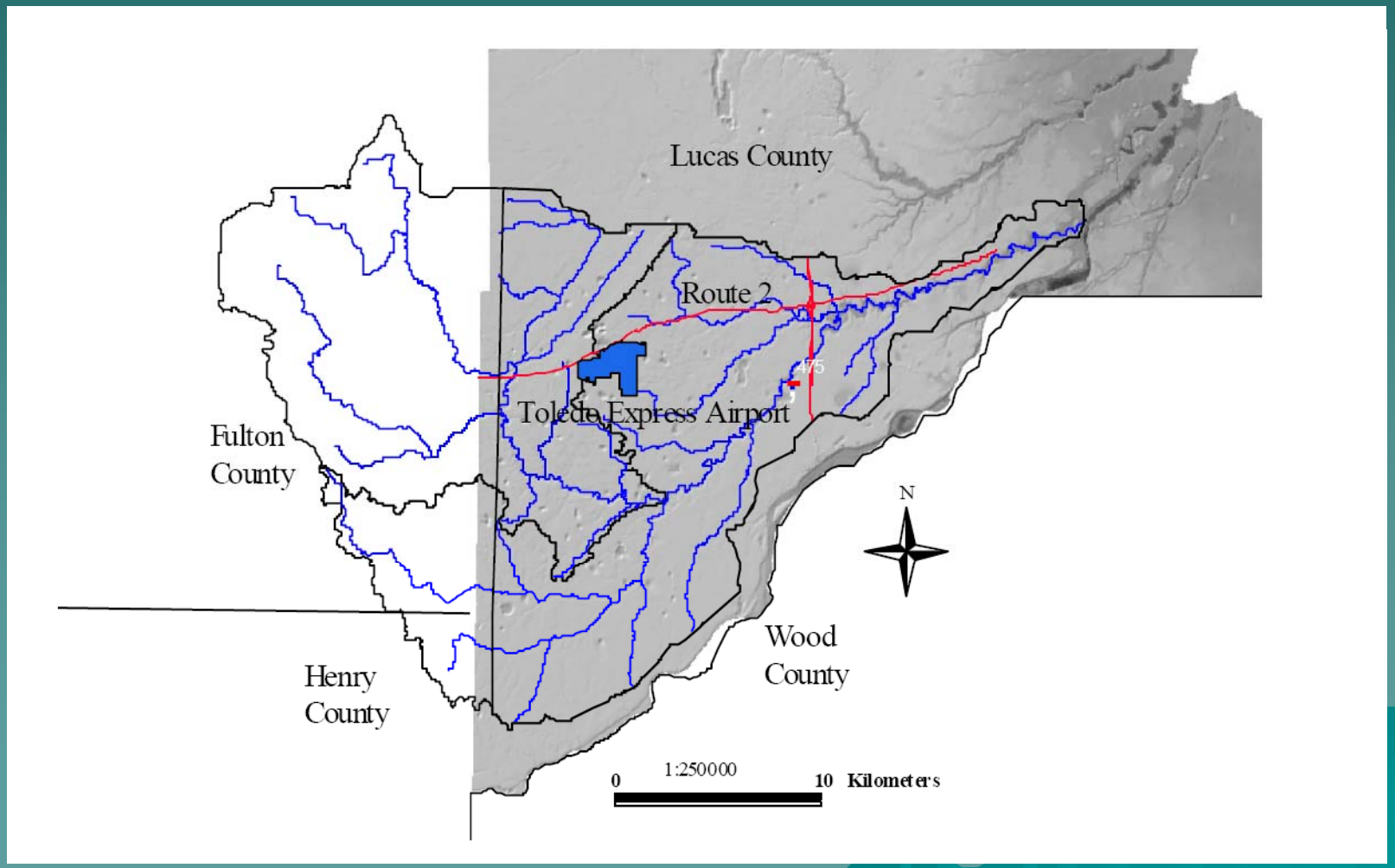

HIGHLAND PARK
PROJECT LOCATION
AIRPORT HIGHWAY
SWAN CREEK
DETROIT AVENUE
CHAMPION STREET BRIDGE
SOUTH AVENUE BRIDGE
N

Swan Creek Background

(Hydrologic Units 04100009 070 and 04100009 080)

- Approximately 204 sq.mi. watershed
- Swan Creek is almost 40 miles long
  - Average gradient is roughly 2.1 ft/mi
- Project location river-mile 4.5
  - Watershed of approximately 195 sq.mi
- Dam mitigation will restore passage to lower 11 miles of the creek
  - 95th percentile flow is ~30 cfs.
  - 100-yr event flow is ~6,000 cfs

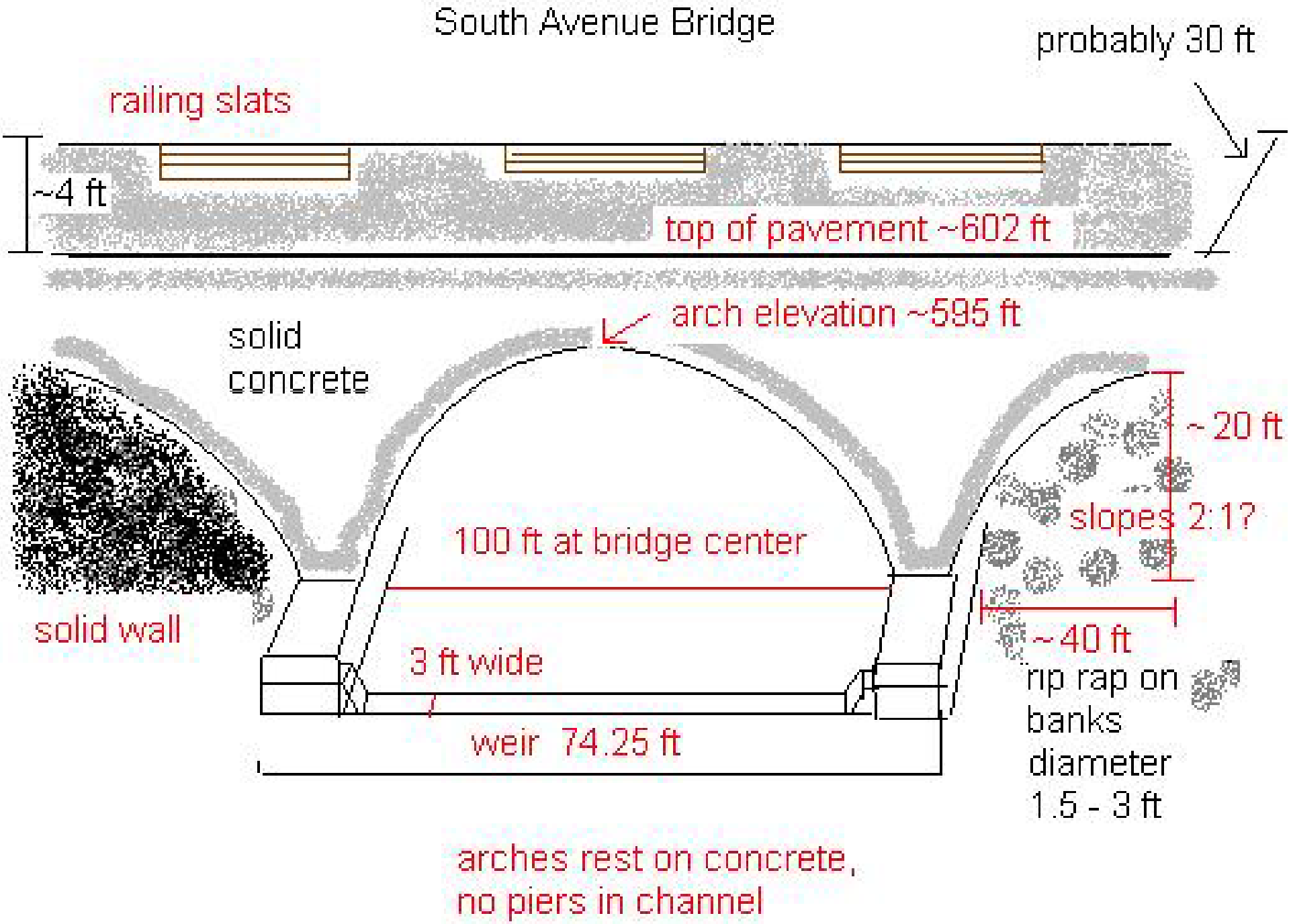
Swan Creek watershed as it drains from Fulton and Henry Counties into Lucas County and the Maumee River

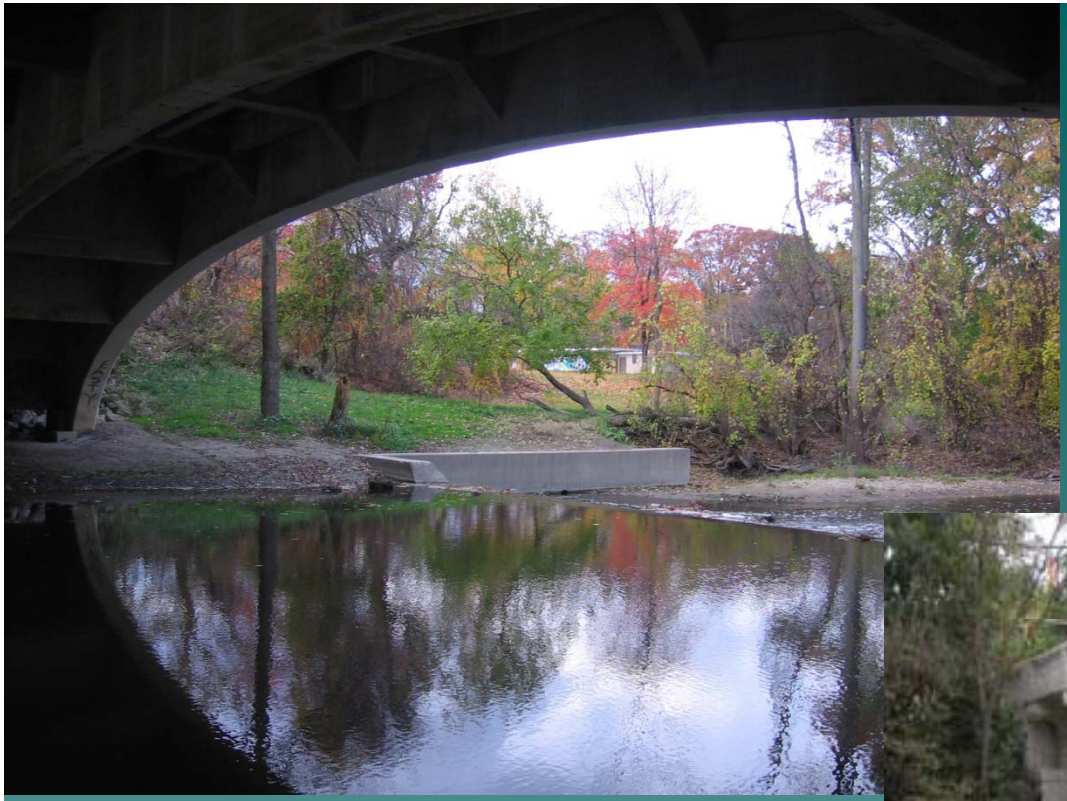


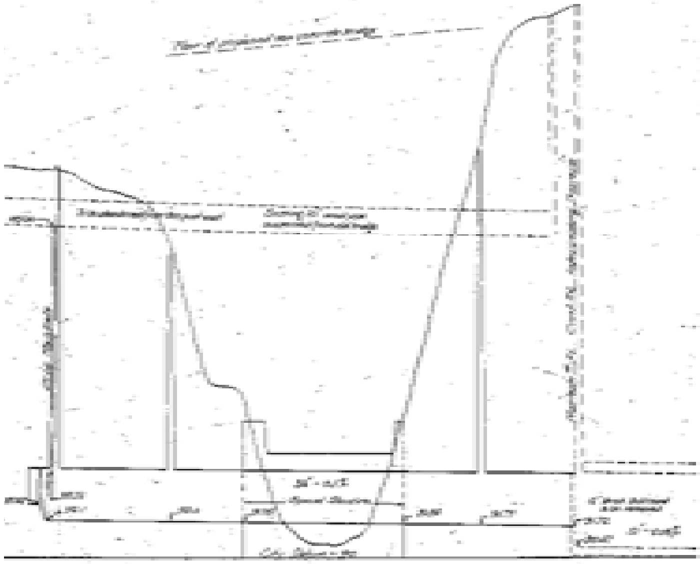
Project Goals and Objectives

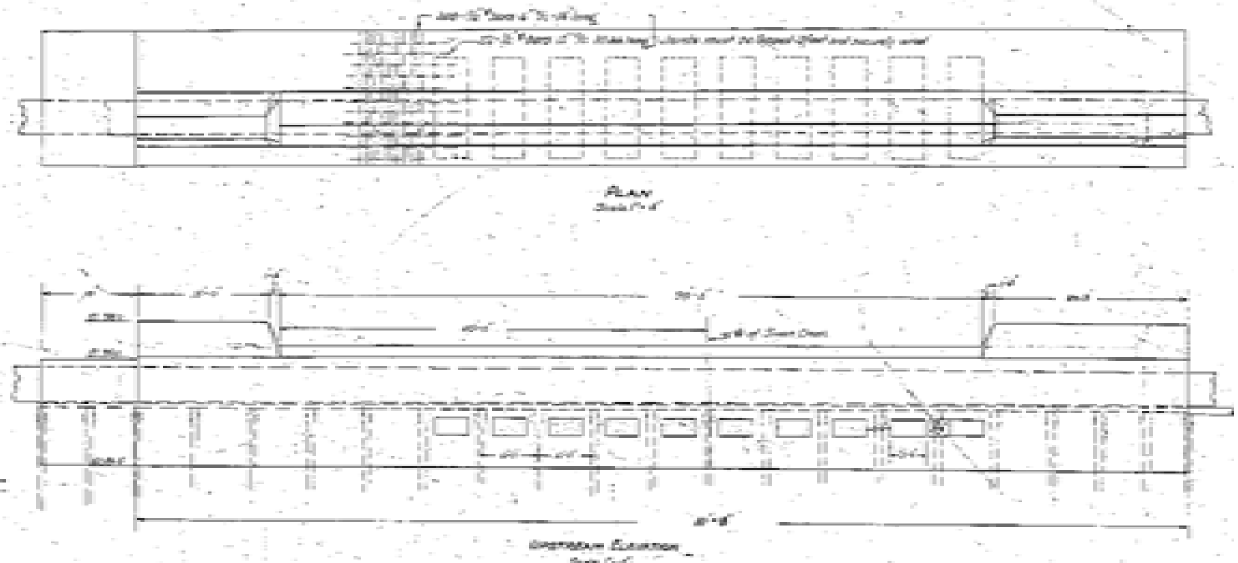
- The goals of the project include:
  - effectively eliminating the barrier to fish passage
  - eliminating the safety hazard to fisherman and curious park guests
  - improving aquatic and riparian habitat without removing the dam

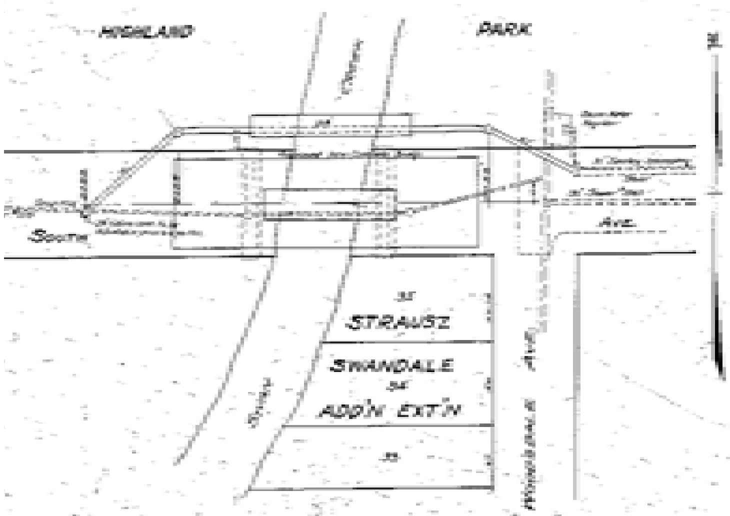

Flow
Proposed Project Area
Dam Location
CHAMPION ST
SOUTH AV
BOW ST
STORRS ST
FINCH ST
FINCH AIRPORT AL
S DETROIT AV
S FEARING BL
DETROIT SHASTA AL
SHASTA DR
N HAVEN DR
WOODSDALE AV
TORONTO AV
GENEVA AV
Legend
Swan Creek
City of Toledo Property - Highland Park
N
0
125
500
750
1,000
Feet

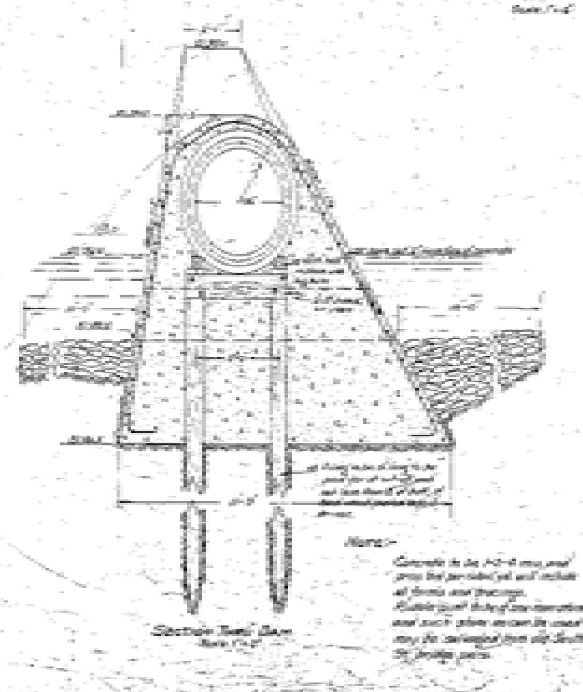

South Avenue Bridge
probably 30 ft
railing slats
~4 ft
top of pavement ~602 ft
arch elevation ~595 ft
solid
concrete
~ 20 ft
slopes 2:1?
100 ft at bridge center
solid wall
~ 40 ft
3 ft wide
rip rap on
banks
diameter
1.5 - 3 ft
weir 74.25 ft
arches rest on concrete,
no piers in channel











ESTIMATE

ITEM	[illegible]	[illegible]
[illegible]	[illegible]	
[illegible]	[illegible]	
Standard Manholes [illegible]	4	
[illegible]	1	
[illegible]	[illegible]	
[illegible]	1	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	[illegible]	
[illegible]	52	
[illegible]	52	
[illegible]	[illegible]	
[illegible]	[illegible]	
Total Length	[illegible]	
[illegible]	[illegible]	

DATA

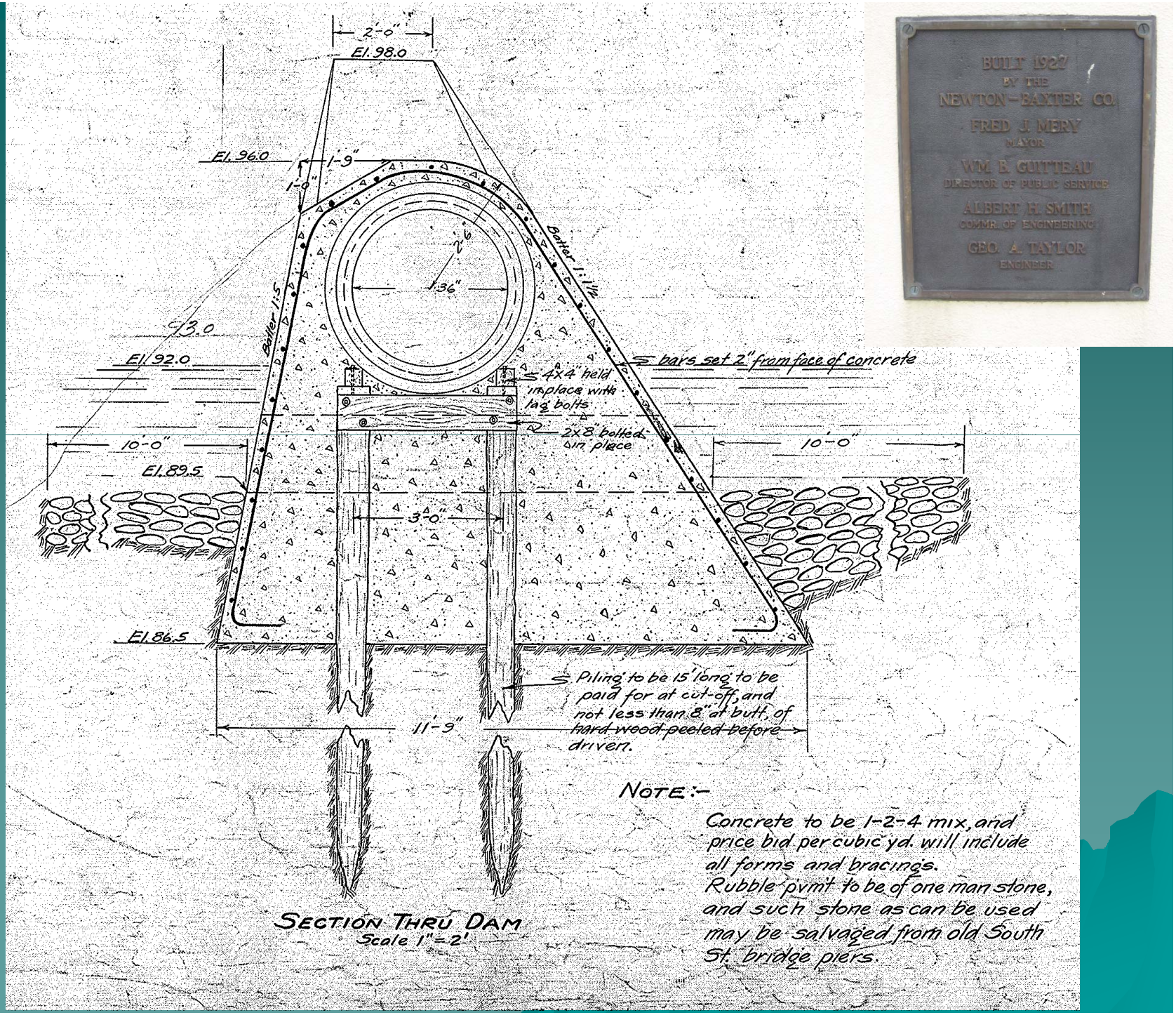
RESOLUTION PASSED ______
ORDINANCE PASSED ______
CONTRACT LET ______ TO ______
ACCEPTED ______ TIME ______
ENGINEER IN CHARGE ______
IMPROVEMENT BOOK ______ PAGE ______
PROFILE ______ BOOK ______ PAGE

BENCH MARKS

DEPT. OF PUBLIC SERV[illegible]
DIVISION OF ENGINEERING & CONSTR[illegible]
TOLEDO, OHIO

DUPLICATE [illegible] SEWER N[illegible]

CONTRACT Nº I


2'-0"
El. 98.0
El. 96.0
1'-9"
1'-0"
Batter 1:1½
Batter 1:1½
13.0
El. 92.0
bars set 2" from face of concrete
4x4" held in place with lag bolts
2x8" bolted in place
10'-0"
10'-0"
El. 89.5
3'-0"
El. 86.5
Piling to be 15' long to be paid for at cut-off, and not less than 8" at butt, of hard wood peeled before driven.
11'-9"
NOTE:-
Concrete to be 1-2-4 mix, and price bid per cubic yd. will include all forms and bracings.
Rubble pvmt to be of one man stone, and such stone as can be used may be salvaged from old South St. bridge piers.
SECTION THRU DAM
Scale 1" = 2'

BUILT 1927
BY THE
NEWTON-BAXTER CO.
FRED J. MERY
MAYOR
WM. B. GUITTEAU
DIRECTOR OF PUBLIC SERVICE
ALBERT H. SMITH
COMM. OF ENGINEERING
GEO. A. TAYLOR
ENGINEER

Design Process

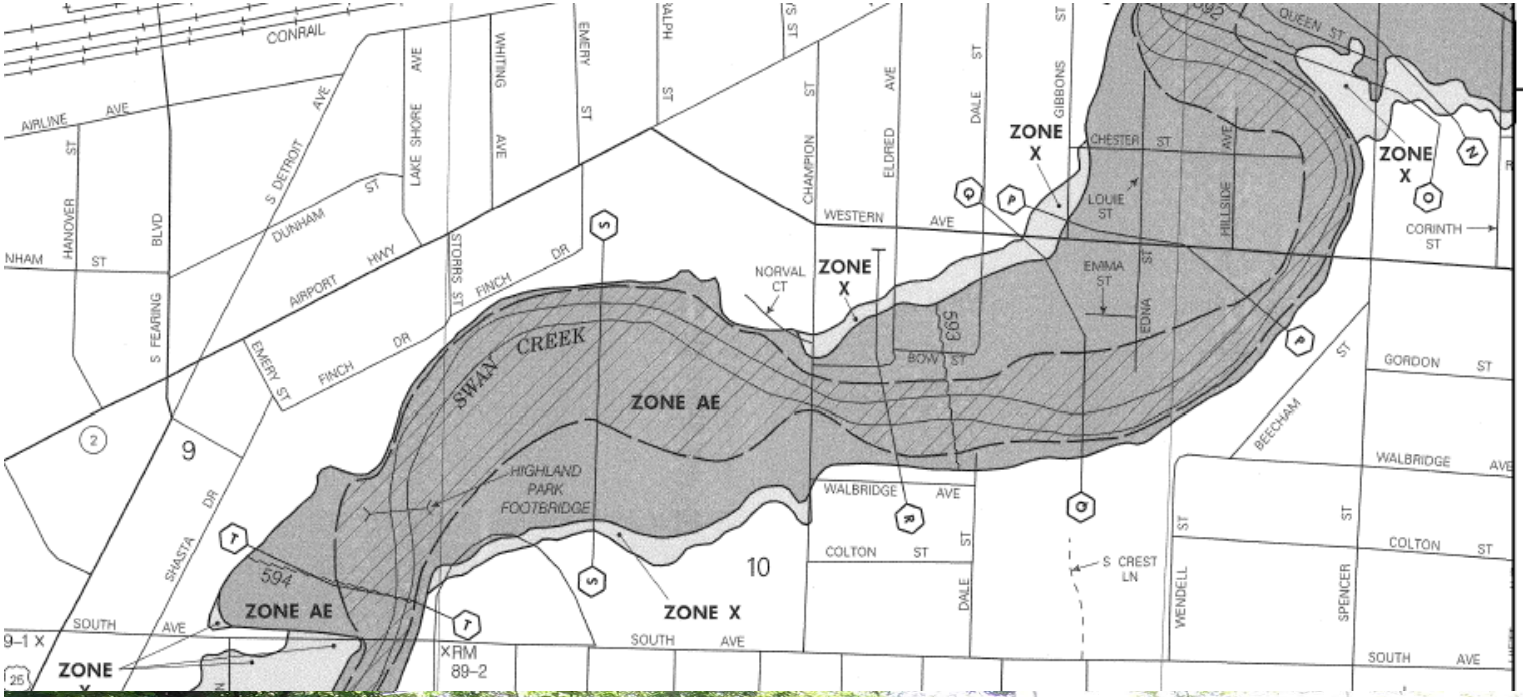
- Channel profile and cross-section survey
- Bed characterization
- Hydraulic/Hydrologic model calibration
- Design alternatives
- Alternative selection
  - Cross vanes
  - W weir
  - Rock ramps
- Selected alternative analysis

Fish Passage Considerations

- Most fish have burst speed capabilities of roughly 8 lengths per second
  - Small fish can't swim as fast but often swim closer to the bottom where, in a rock rapids, the velocities are lower
- Average velocities are much less important than the distribution of velocity. The actual cutoff for passage is less than the burst speed since the fish has to move forward but velocities near the bed are low when roughness is high (boulder and rock)

Floodplain analysis

- To determine the effect of the proposed mitigation measures on the floodplain, a hydraulic analysis was conducted of Swan Creek
  - Although the countywide Flood Insurance Study (FIS) was published in 2000, the hydrologic and hydraulic analyses for Toledo were finished in April 1978
  - The JFNew Team performed a detailed field analysis of creek geomorphology between the South Avenue Bridge and Champion Street Bridge (upstream and downstream of Highland Park) and documented bankfull indicators, “low flow” water levels, and cross-sectional elevations of the creek channel and flood plain
  - The 1978 HEC-2 model was obtained from the Federal Emergency Management Agency (FEMA) for Swan Creek as a basis for the hydraulic analysis



500 0 500 FEET

NATIONAL FLOOD INSURANCE PROGRAM

FIRM

FLOOD INSURANCE RATE MAP

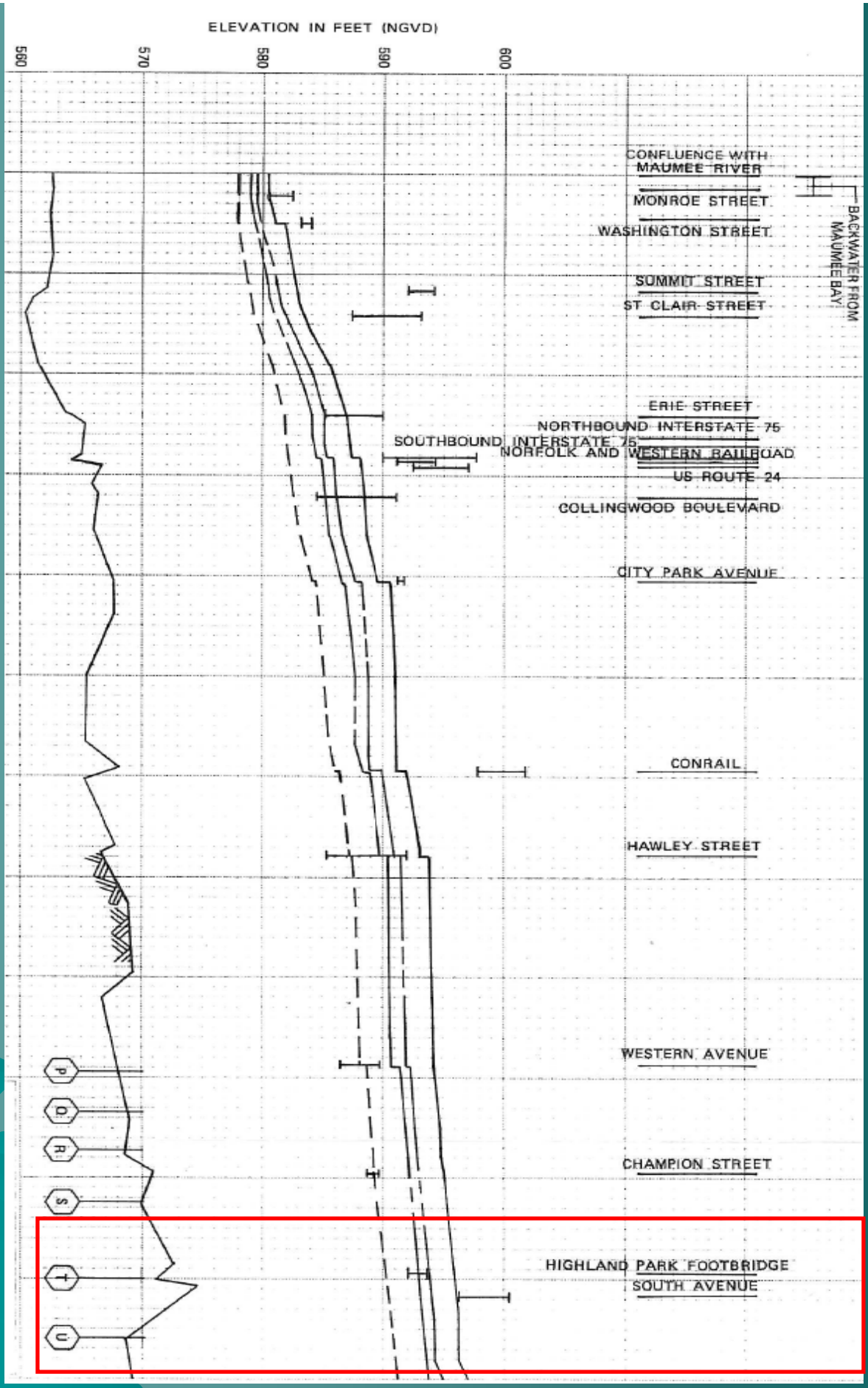
LUCAS COUNTY,
OHIO
AND INCORPORATED AREAS

PANEL 89 OF 405

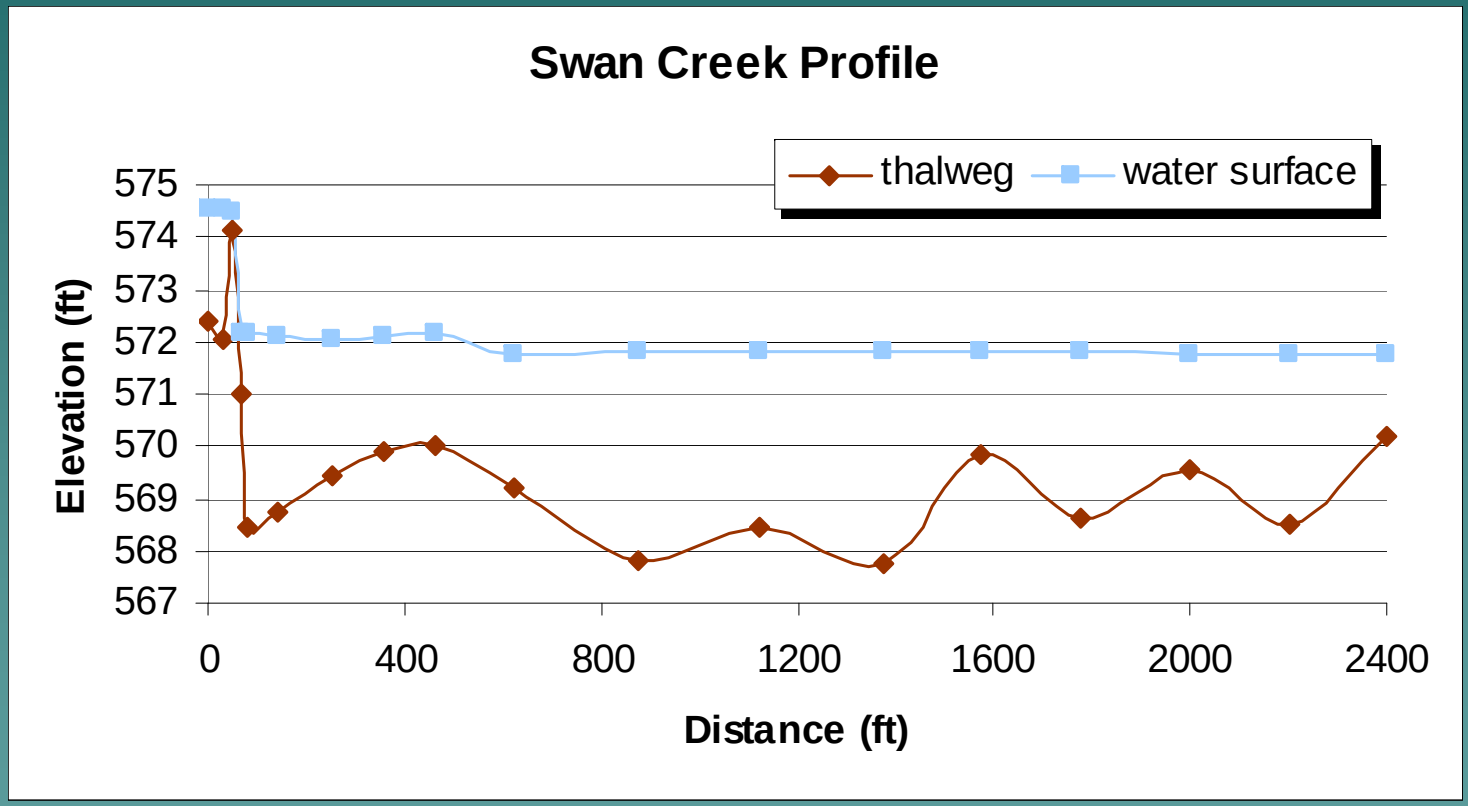
(SEE MAP INDEX FOR PANELS NOT PRINTED)

CONTAINS:

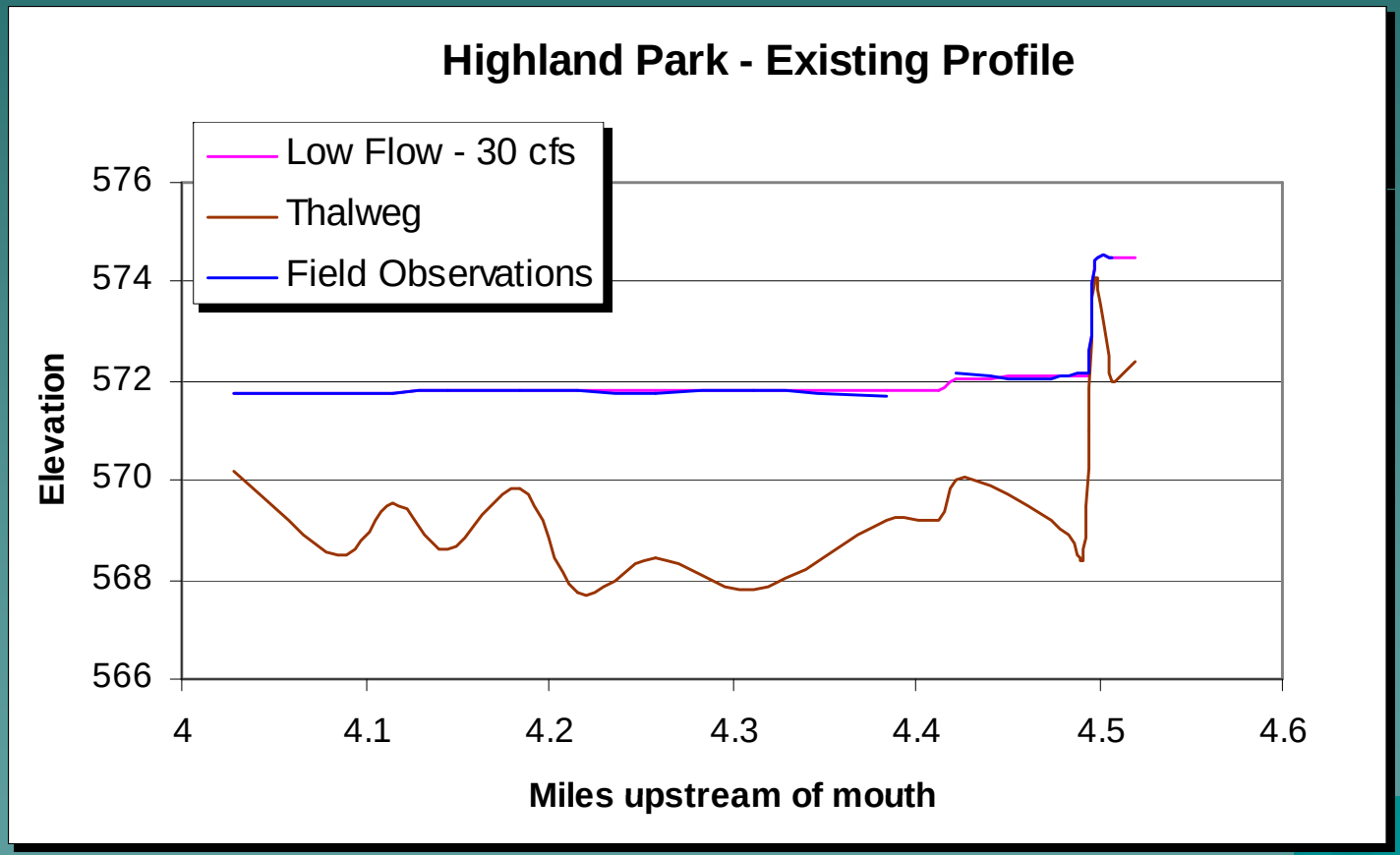
COMMUNITY	NUMBER	PANEL	SUFFIX
TOLEDO, CITY OF	395373	0089	D


ELEVATION IN FEET (NGVD)
560
570
580
590
600
CONFLUENCE WITH MAUMEE RIVER
MONROE STREET
WASHINGTON STREET
SUMMIT STREET
ST CLAIR STREET
BACKWATER FROM MAUMEE BAY
ERIE STREET
NORTHBOUND INTERSTATE 75
SOUTHBOUND INTERSTATE 75
NORFOLK AND WESTERN RAILROAD
US ROUTE 24
COLLINGWOOD BOULEVARD
CITY PARK AVENUE
CONRAIL
HAWLEY STREET
WESTERN AVENUE
CHAMPION STREET
HIGHLAND PARK FOOTBRIDGE
SOUTH AVENUE
P
Q
R
S
T
U

JFNew Survey Results



HEC-RAS Model Calibration



Modeling Results

Flow Event	Avg Velocity of Reach	Max Velocity in Reach
	ft/sec	ft/sec
1 Year	3.5	5
2 Year	4.1	5.8
10 Year	4.9	7.3
50 Year	6.2	9.5
100 Year	6.4	10.1

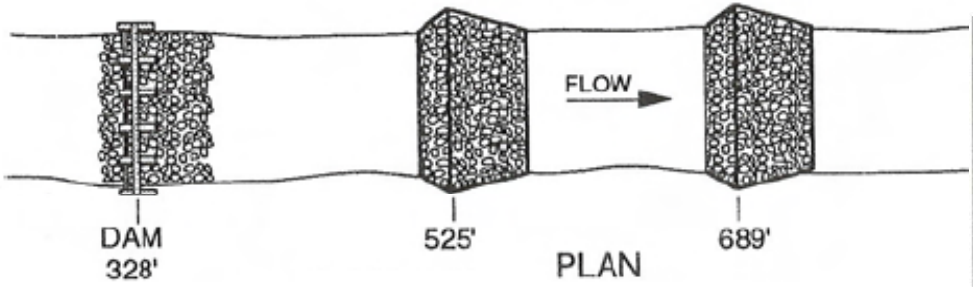
HEC Model Shear	Rock Size *	Shear based Cross-sectional Area	Rock Size *	Rock Size based on USACE (1991)	Rock Size based on Robinson et. al. (1998)
(lb/ft2)	(in)	(lb/ft2)	(in)	(in)	(in)
1.98	6.8	3.39	9.9	24	13

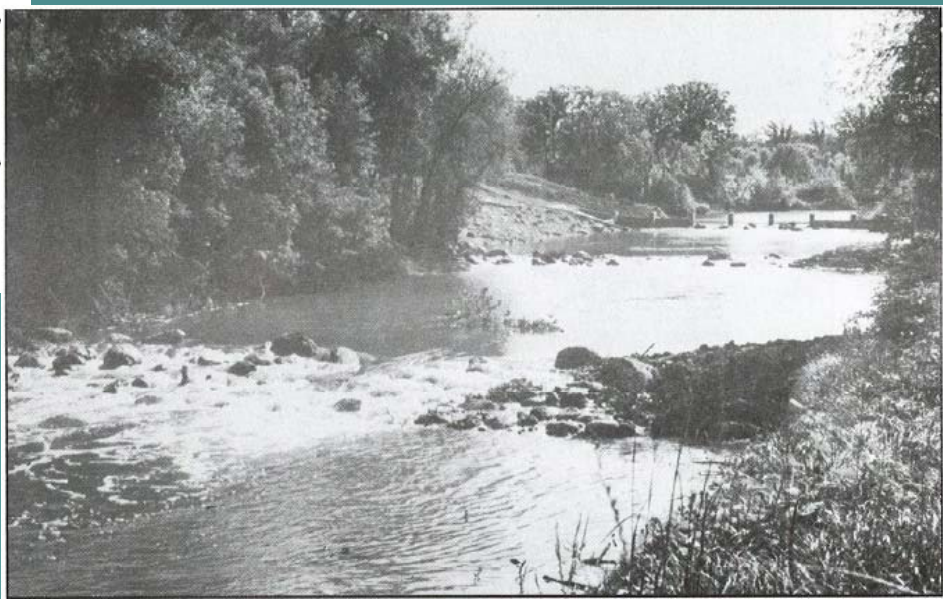
* incorporates Safety Factor of 1.5

USACE (1991) based on design unit discharge and slope of rock ramp
Robinson et al. (1998) based on design unit discharge and slope of rock ramp

Solution: Rock/Fish Ramps

- Based on work of Newbury, Gaboury, and Erickson on Roseau River in Manitoba
- Series of “rock ramps” and pools





Fish Passage Considerations

- Our strategy is to make rapids that function as a step pool system and have complex velocity distributions and rough beds
- The boulder weirs create lower velocity pools and the higher velocities that flow over them are spatially short facilitating burst speed capabilities

Design Resources

RECLAMATION
Managing Water in the West

Rock Ramp Design Guidelines

U.S. Department of the Interior
Bureau of Reclamation
Technical Service Center
Denver, Colorado

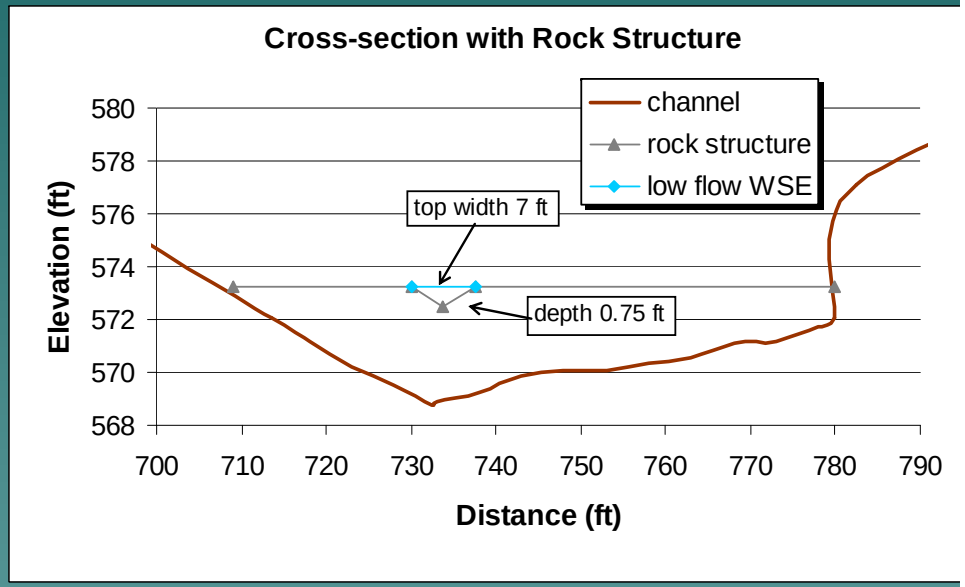
September 2007

Pool And Riffle Fishways For Small Dams

Manitoba
Natural Resources
Fisheries Branch

Rock Ramp Design

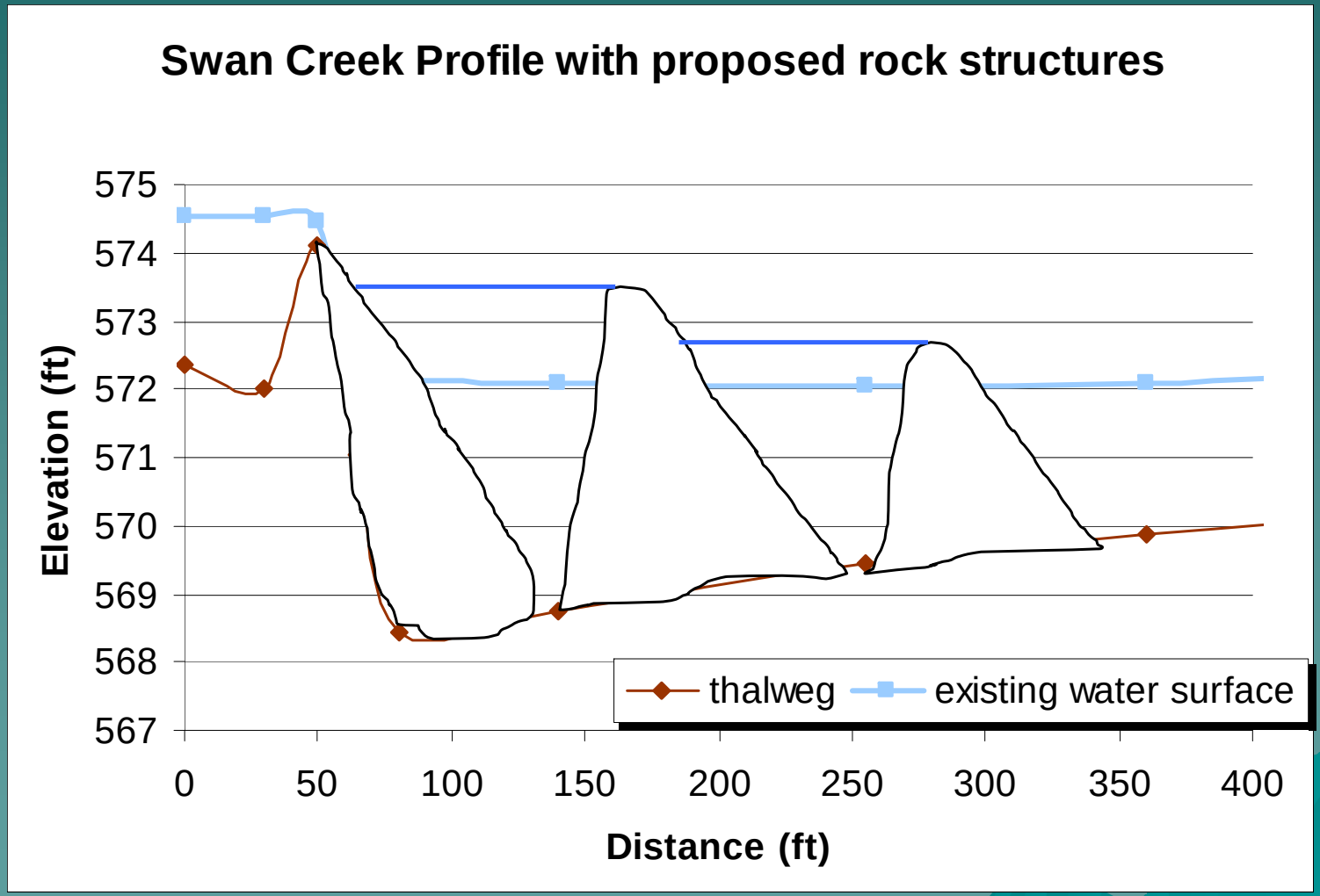
- Sized to contain 0.75 to 1 ft water depth during low flows (30-50 cfs)
- Velocity in notch ~2.5 ft/s
  - 4 inch fish could pass (based on burst capabilities of 8 body lengths / sec)*
- Hydraulically Diverse
  - Resting spots for fish behind large boulders

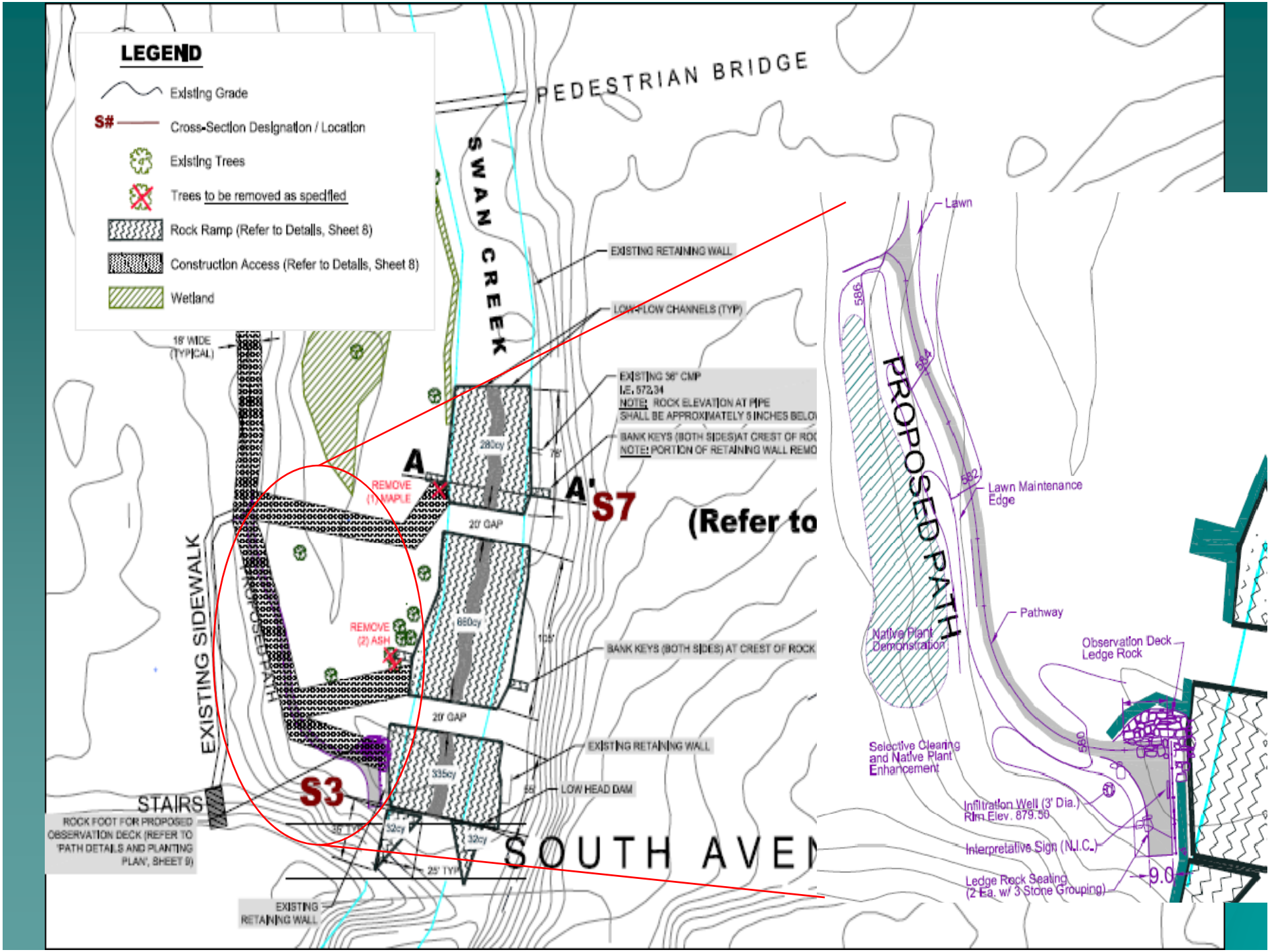


* Personal communication with Luther Aadland, regional expert in rock ramp design, consultant for Minnesota DNR

Rock Ramp Design

Rock Ramp Design



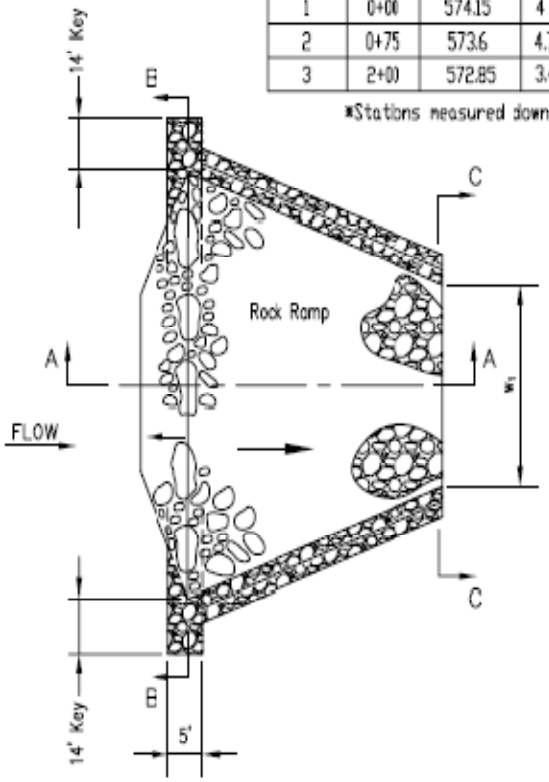

LEGEND
Existing Grade
S#
Cross-Section Designation / Location
Existing Trees
Trees to be removed as specified
Rock Ramp (Refer to Details, Sheet 8)
Construction Access (Refer to Details, Sheet 8)
Wetland
PEDESTRIAN BRIDGE
SWAN CREEK
EXISTING RETAINING WALL
LOW-FLOW CHANNELS (TYP)
18' WIDE (TYPICAL)
EXISTING 36" CMP
I.E. 872.34
NOTE: ROCK ELEVATION AT PIPE
SHALL BE APPROXIMATELY 5 INCHES BELO
BANK KEYS (BOTH SIDES)AT CREST OF RO
NOTE: PORTION OF RETAINING WALL REMO
A
A'
S7
(Refer to
280cy
REMOVE (1) MAPLE
20' GAP
EXISTING SIDEWALK
REMOVE (2) ASH
660cy
BANK KEYS (BOTH SIDES) AT CREST OF ROCK
20' GAP
EXISTING RETAINING WALL
335cy
S3
LOW HEAD DAM
STAIRS
ROCK FOOT FOR PROPOSED OBSERVATION DECK (REFER TO 'PATH DETAILS AND PLANTING PLAN', SHEET 9)
32cy
32cy
25' TYP
SOUTH AVE
EXISTING RETAINING WALL
Lawn
586
584
PROPOSED PATH
582
Lawn Maintenance Edge
Pathway
Native Plant Demonstration
Observation Deck Ledge Rock
580
Selective Clearing and Native Plant Enhancement
Infiltration Well (3' Dia.) Rim Elev. 879.50
Interpretative Sign (N.I.C.)
Ledge Rock Seating (2 Ea. w/ 3 Stone Grouping)
9.0

Rock Ramp Design

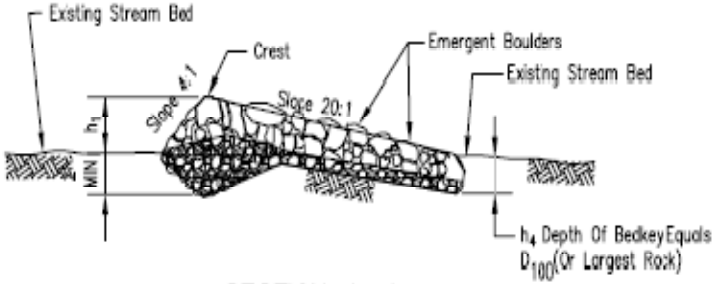
($h_2 = h_1 + 0.75'$)

Riffle No.	*Station	Control Elev.	h_1	h_2	h_3	h_4	W_1
1	0+00	574.15	4	4.75	5.75	3.0	86
2	0+75	573.6	4.75	5.5	6.5	3.0	67
3	2+00	572.85	3.4	4.15	5.15	3.0	56

*Stations measured downstream from dam.



PLAN

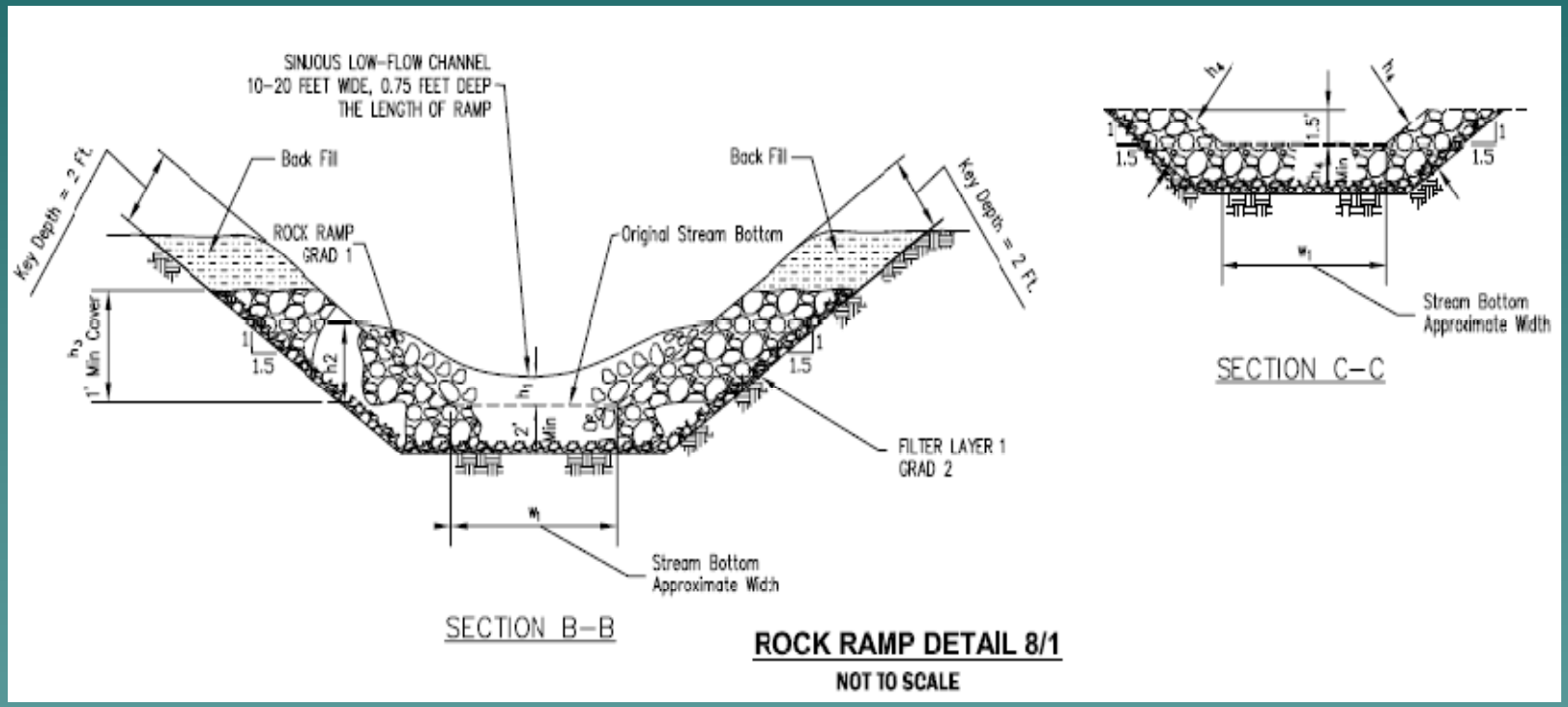


SECTION A–A

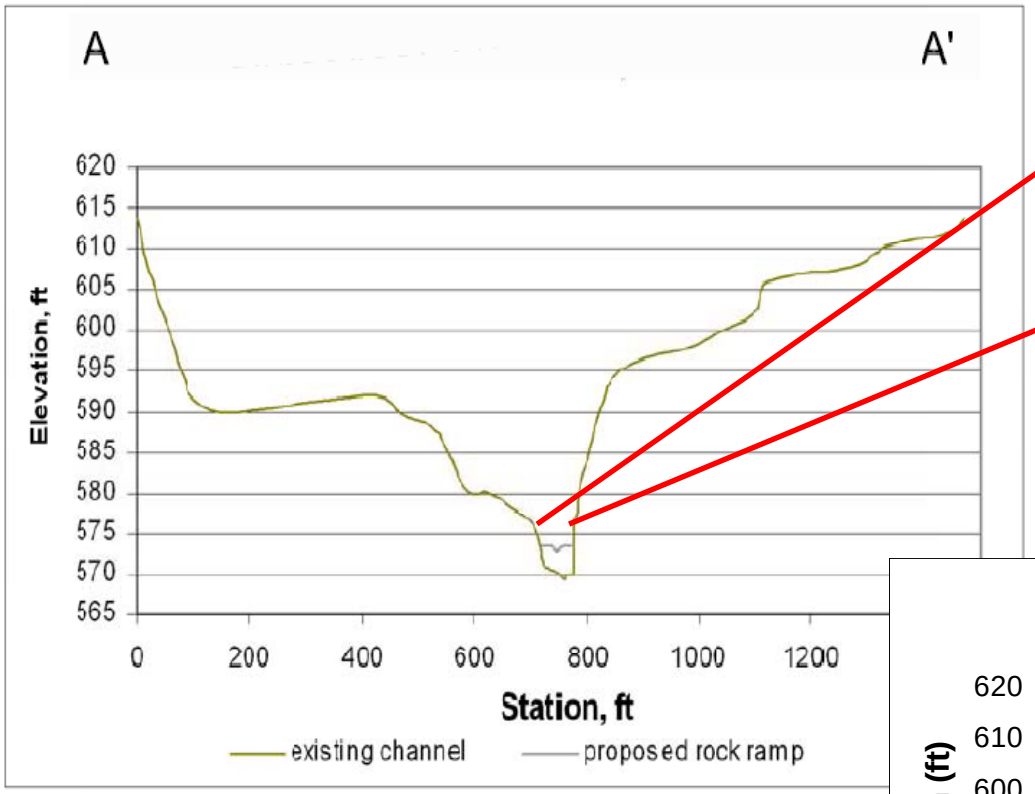
REFERENCE TABLE			
ROCK LAYER NAME	ROCK GRAD.	h_4	D_{50}
ROCK RAMP	1	3.(Ft.	24 In.
FILTER LAYER 1	2	4.25 In.	2.5 In.

NOTES:
1. Rock gradation shall meet ODOT requirements.
2. Use largest individual stones from available material as shown for the emergent boulders and crest stone.
3. Ramps shall consist of the main Rock Ramp layer and 1 filter layer.
4. Scour holes shall be excavated pror to applicatior of rock.
5. See Profile Detail 7/3 for Proposed Stream Elevatons.

Rock Ramp Design

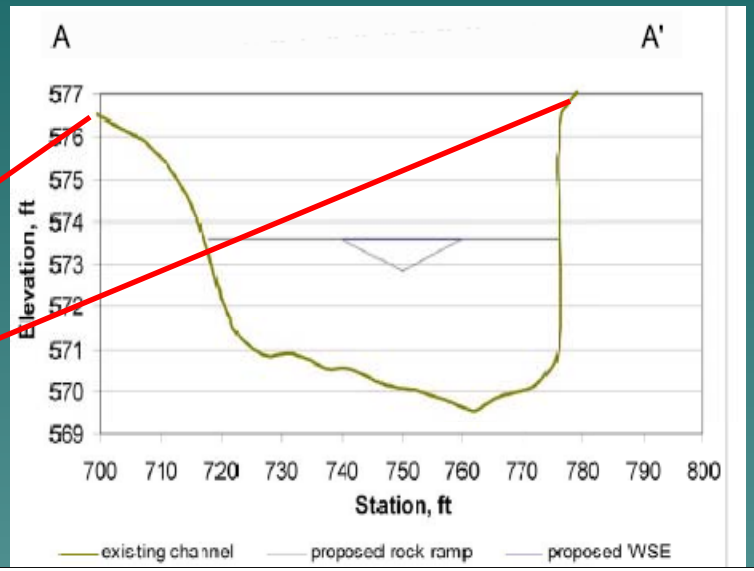


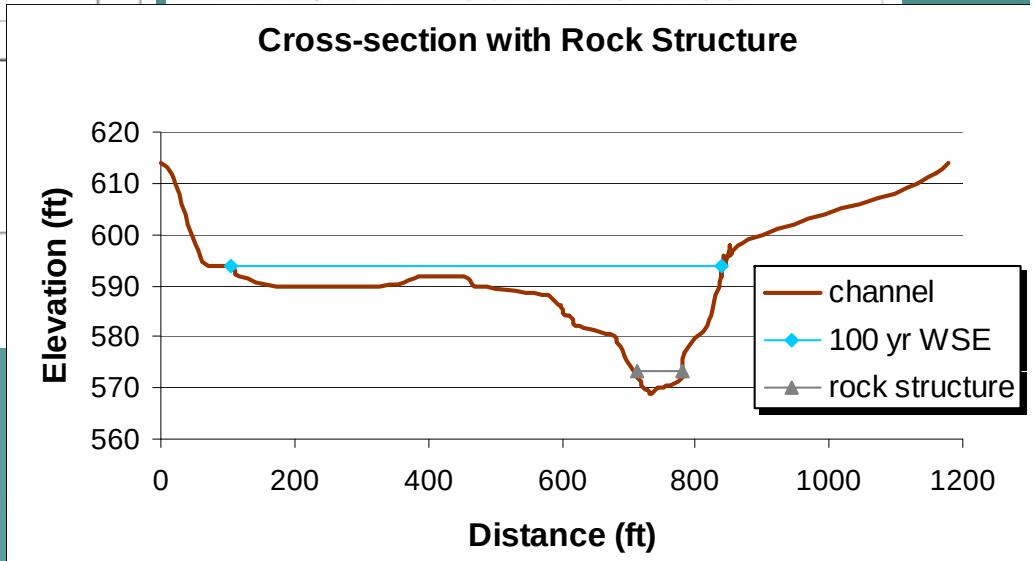
Rock Ramp Relative Size



EXISTING SECTION A - A' (DETAIL 7/1)

NOT TO SCALE





Native Seed and Plugs

Botanical Name	Common Name	PLS Oz Per Acre
Avena sativa	Seed Oats	128
Carex crinita	Fringed sedge	1
Carex emoryi	Riverbank sedge	1
Carex frankii	Bristly cattail sedge	2
Carex grayi	Common bur sedge	0.5
Carex lupulina	Common hop sedge	1
Carex muskingumensis	Swamp oval sedge	1
Carex vulpinoidea	Brown fox sedge	2
Cinna arundinacea	Common wood reed	1
Coreopsis tripteris	Tall coreopsis	1
Elymus riparius	Riverbank wild rye	4
Elymus virginicus	Virginia wild rye	32
Eupatorium maculatum	Spotted joe-pye weed	1
Eupatorium perfoliatum	Common boneset	0.5
Eupatorium purpureum	Purple joe-pye weed	1
Hibiscus moscheutos	Swamp rose mallow	1
Juncus effusus	Common rush	0.25
Juncus tenuis v. dudleyi	Dudley's rush	0.1
Liatris spicata	Marsh blazing star	0.25
Lobelia cardinalis	Cardinal flower	0.25
Lobelia siphilitica	Great blue lobelia	0.25
Lolium multiflorum	Annual rye	40
Monarda fistulosa	Wild bergamot	0.5
Panicum virgatum	Switch grass	2
Rudbeckia laciniata	Wild golden glow	2
Spartina pectinata	Prairie cord grass	2
Verbesina alternifolia	Wingstem	2
Zizia aurea	Golden Alexanders	0.25
	Total PLS Ounces	**227.85**

Botanical Name	Common Name	# Plugs
Grass:		
Elymus canadensis	Canada Wild Rye	114
Panicum virgatum	Switchgrass	114
Schizachyrum scoparium	Little Bluestem	114
Sorghastrum nutans	Indian Grass	114
Forbs:		
Aquilegia canadensis	Columbine	76
Asclepias tuberosa	Butterfly Milkweed	76
Aster azureus	Sky-blue Aster	114
Aster laevis	Smooth Blue Aster	76
Coreopsis lanceolata	Lance-leafed Coreopsis	76
Coreopsis tripteris	Tall Coreopsis	114
Echinacea purpurea	Purple Coneflower	76
Eupatorium rugosum	Snakeroot	76
Euphorbia corollata	Flowering Spurge	76
Helianthus occidentalis	Western Sunflower	38
Helianthus strumosus	Pale-Leaved Sunflower	76
Monarda fistulosa	Bergamot	76
Penstemon hirsutus	Hairy Beard's Tongue	76
Ratibida pinnata	Gray-headed Coneflower	76
Rudbeckia hirta	Black-eyed Susan	76
Solidago nemoralis	Gray Goldenrod	76
Solidago rigida	Stiff Goldenrod	76
Verbena stricta	Hoary Vervain	114
Veronicastrum virginicum	Culver's Root	76
	Total Plugs	**1976**

Lessons Learned

- Beware the Indiana Bat (in suitable habitat areas have to be wary of dead and dying trees)
- Investigate location of existing infrastructure very carefully (redundant searches, run down every detail yourself). Never assume anyone else will do it for you.
- Spend time and money up front with very detailed site survey
- Plan carefully for stone volume – include voids, include “sinkage” factor, include irregularities of surface to be filled.
- Did not necessarily need to estimate flow through ramp.

Lessons Learned, cont'd

- If silt/turbidity curtain is needed for entirely crossing a river, may need to plan for long lead time. Proper curtains are mostly custom-made.
- If there is an Flood Insurance Study, need to procure existing floodplain model. Provide ample time.
- Be flexible, but do not work outside of original work limits without careful investigation.

The Future…

- Dominion City Dam, Rousseau River, from Pool and Riffle Fishways for Small Dams, 1995. Manitoba Natural Resources, Fisheries Branch. Gaboury, M.N., Newbury, R.W., and Erickson, C.M.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