DuPage River Salt Creek Workgroup

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DuPage/Salt Creek Special Conditions Report

March 31, 2017

Contents

Introduction and Participation DuPage/Salt Creek Special Conditions Report March 31, 2017.

This report is intended to fulfill certain reporting requirements contained in DRSCW NPDES permits' Special Conditions. These conditions are entitled DuPage/Salt Creek Special Requirements (see attachment 1).

These special conditions are contained in the NPDES permits identified in the following table. Listed permittees are required to ensure the completion of projects and activities set out in the special condition (Special Conditions, paragraph 2, table). Other permittees are required to only participate in identified watershed level studies and a chloride abatement program. Table 1 identifies the status of funding these activities by each permittee.

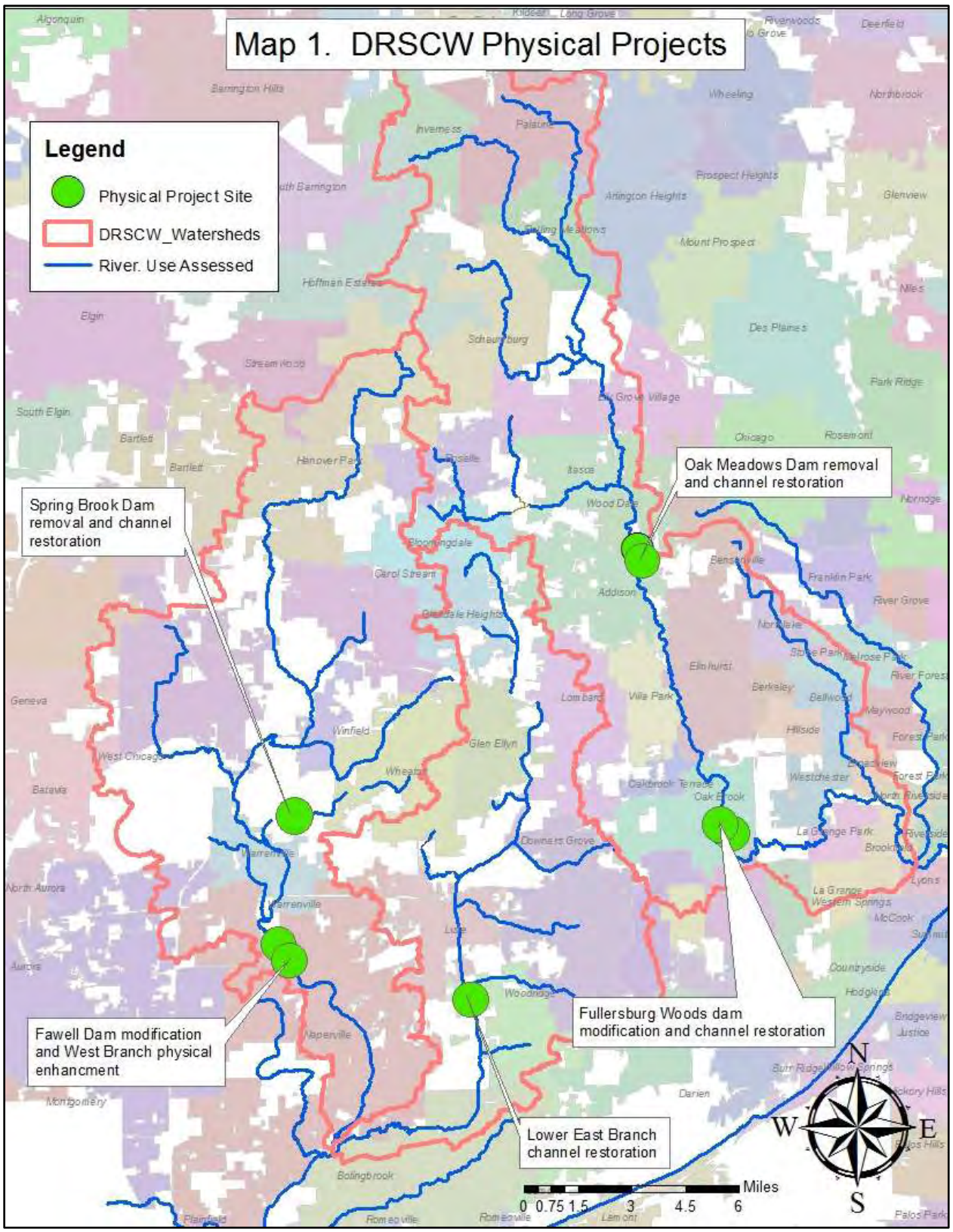
POTW Owner/ Facility Name	NPDES No.	Membership Dues Paid 2016-2017	Assessment Paid For Paragraph 2 Table Project Funding	Assessment Paid for Chloride Reduction/NIP/QUAL 2k/Trading Program
Addison North STP	IL0033812	YES	YES	YES
Addison South - AJ LaRocca	IL0027367	YES	YES	YES
Bartlett WWTP	IL0027618	YES	YES	YES
Bloomingdale-Reeves WRF	IL0021130	YES	YES	YES
Bolingbrook STP#1	IL0032689	YES	YES	YES
Bolingbrook STP#2	IL0032735	YES	YES	YES
Carol Stream WRC	IL0026352	YES	YES	YES
Downers Grove SD	IL0028380	YES	YES	YES
DuPage County Woodridge	IL0031844	YES	YES	YES
Elmhurst WWTP	IL0028746	YES	YES	YES
Glenbard WW Authority STP	IL0021547	YES	YES	YES
Glendale Heights STP	IL0028967	YES	YES	YES
Hanover Park STP#1	IL0034479	YES	YES	YES

Roselle-Devlin STP	IL0030813	YES	YES	YES
Roselle-J Botterman WWTF	IL0048721	YES	YES	YES
Salt Creek SD	IL0030953	YES	YES	YES
West Chicago STP	IL0023469	YES	YES	YES
Wheaton SD	IL0031739	YES	YES	YES
Wood Dale North STP	IL0020061	YES	YES	YES
Wood Dale South STP	IL0034274	YES	YES	YES
Bensenville South STP	IL0021849	YES	N/A	YES
Itasca STP	IL0079073	YES	N/A	YES

Table 1. Participation in the DRSCW Special Condition 2016-2017. N/A means that the agency does not have that condition in their permit.

All listed permittees participate in the DuPage River Salt Creek Workgroup and are working with other watershed members of the DRSCW to determine the most cost effective means to remove dissolved oxygen (DO) and offensive condition impairments in the DRSCW watersheds.

The specific reporting requirements addressed herein include annual reporting on progress of the projects listed in the paragraph 2 table, and certain baseline condition reporting for the Chloride Reduction Program.



Map 1. Map of physical projects set out in the Special Condition

1. Progress on Projects Listed in Special Conditions Paragraph 2

Projected expenses and funds allocated for project activities are identified in the current DRSCW Five-Year Financial Plan. Map 1 shows the physical project sites covered in this section.

1.1 Table Items 1 and 2: Oak Meadows Dam Removal and Stream Restoration

- Special Condition Listed Completion Date – December 2016 (dam), December 2017 (channel restoration)
- Status – Complete.

1.1.1 Site Description and Project Design

- A site description and the design plan was provided in the 2016 report.

1.1.2 Project Implementation

- Table 2 shows the schedule of project implementation activities.

Activity	Date	Status
Design and permitting	2012-2015	Complete
Ground breaking	7/7/15	Complete
Stream diversion	9/6/15	Complete
Dam removal	9/12/15	Complete
Stream and bank enhancements	9/6/15-7/15/16	Complete
Planting riparian areas	10/12/15-10/1/16	Complete
Planting upland areas	9/1/16-11/11/16	Complete
Reintroduction of flow into Oak Meadows portion of Salt Creek	7/15/16	Complete
Monitoring plantings	2017-2021	On going
Habitat and mIBI assessment	July 2017, 2018, 2019	Scheduled
Opening site to public	June/July 2017	Scheduled

Table 2. Schedule of activities to complete the Oak Meadows Dam Removal and Stream Restoration Project.

Attachment 2 of this report includes a summary of post project conditions.

1.1.3 Project Impact Evaluation

With construction complete, the project is moving into the impact evaluation phase. The objectives of the project are to:

- Improve Qualitative Habitat Evaluation Index (QHEI) scores in a 1.3-mile stretch of the Salt Creek mainstem. QHEI measures sinuosity, bed and bank conditions, gradient, riparian and pool and riffles conditions. The site was evaluated at two locations and scored 51 (SC34) and 52 (SC35) placing it in the poor category of QHEI. The project aims to improve scores in all categories except gradient. It should be noted that the low gradient at the site also limits the possibilities for riffle construction at the site.

- Increase both the macroinvertebrate Index of Biological Integrity scores (mIBI) and the presence/numbers of high value taxa in the 1.3-mile stretch of Salt Creek mainstem contained in the project footprint (see table 3 for pre-project scores). The potential post project high value taxa list was compiled by reviewing taxa lists from two reference sites on Salt Creek with high macroinvertebrate scores. Fourteen rheobiotic and hard or coarse substrate associated taxa were identified at the sites listed in table 3. All 14 were found at one or both of the reference sites, but only six have been collected inside the project footprint. A third mIBI ad–hoc sample site was added in 2014 and identified as SC35A (see table 3).

- Improve dissolved oxygen (DO) scores directly upstream of the Oak Meadows Dam. DRSCW continuous DO data records exist for the site 2009-2013. Data collection will start again in June 2017. Diel variation and daily and monthly average and minimums will be compared in the pre and post project data sets.

Site ID	**QHEI 2007**	**mIBI 2007**	**QHEI 2009**	**mIBI 2009**	**QHEI 2013**	**mIBI 2013**	**QHEI 2014**	**mIBI 2014**
SC34	54	28	51	21	52	23.19	54	20.2
SC35	46.5	20	52	24	55.5	24.1	60.5	15.5
SC35A								12.1

Table 3. Observed QHEI and mIBI at the Oak Meadows 2007, 2009 and 2014.

The regular basin wide assessment of biological and QHEI conditions in Salt Creek was executed in 2016 but the Oak Meadows site was not included as it was still under construction.

1.2. Table Item 3. Fawell Dam Modification

- Special Condition Listed Completion Date – December 2018
- Status – in the design and permitting phase

The objective of the project is raise the fish index of biological integrity scores (fIBI) above its current average 18.5 for the three mainstem survey sites immediately upstream of the dam. To accomplish this, the dam's spillway, which consists of three box culverts, will be redesigned to allow fish passage at river mile 8.1 on the West Branch DuPage River. The dam is a flood control structure operated by DuPage

County Stormwater Management and must be fully functional post project. The DRSCW has budgeted $750,390 for this project.

1.2.1 Site Description

The dam itself is located on the West Branch DuPage River at river mile 8.1 in the McDowell Grove Forest Preserve. The dam consists of a set of three gate structures that can control flow through three-barrel concrete box culverts to impound water, as necessary, upstream within the McDowell Grove Forest Preserve. The existing three-barrel concrete box culverts consist of an 11'-10" wide by 10' high center barrel and 10' by 10' side barrels. The culvert barrels are 80' long and the bottom slopes down at 5% from the upstream end to the downstream end. There are concrete wing walls on the upstream side of the culvert structure, and a 50' long concrete stilling basin structure on the downstream side. Atop the culvert, the grade slopes up from the ends to a 25' wide path running perpendicular to the structure, which

Figure 2. Fawell Dam viewed downstream of the dam looking north towards the dam. The three-culvert system is visible in the center of the photograph.

is approximately 10' above the top elevation of the barrels. During low water events, the upstream end of the culvert features a concrete sill set above the natural bed elevation of the river. The earth embankment is approximately 1000' in length. The project is a collaborative effort with DuPage County Stormwater Management (SWM, the dam's manager), the FPDDC and the DRSCW. A "riffle" downstream of the stilling basin also influences flow through the culverts. The consultant team consists of V3 Consultants and Inter-Fluve. DuPage County Stormwater Management is providing modeling expertise.

The 2016 report provided the following reports: Hydraulic, Detailed Channel Topographic Survey, wetland survey, and sediment depth of refusal and quality survey for upstream deposits.

1.2.2 Design Characteristics

Successful fish passage depends on variables such as water velocity, depth, distance between resting positions for the fish, and each fish's ability to swim against the current. Initially, the design team proposed lowering one of the culverts to improve fish passage; further analysis made it apparent that lowering two of the culverts would produce better fish passage with a higher level of confidence.

To ensure fish passage, the project seeks to mimic as closely as possible the depth, velocity and distance requirements encountered by the target fishes in an unmodified system during their spawning or migration periods (March – August). An optimal design would allow fish passage for all flows between the 10% and 95% exceedance levels during this migratory period. The flow duration analysis indicated that these target flows are between 42 and 397 cfs.

A literature review of appropriate target average velocity throughout the stream cross section suggested a target for northern pike and walleye of approximately 123 cm/s (4 ft/s), and an appropriate target average velocity for smallmouth bass, and white suckers of approximately148 cm/s (4.9 ft/s). Smaller fishes tend to be weaker swimmers; most will be able to take advantage of the lower velocities in the boundary layers adjacent to rocks that can be used as resting places behind and between rocks in natural stream. The exception is the black stripe top minnow, which may not be able to use the boundary layer near the stream bottom as it is a surface swimmer.

The project aims to have the deepest water in any cross section be a minimum 8 inches. The full report with reference forms is included in attachment 3 of this report.

1.2.3 Permitting Requirements

The proposed improvements will require a stormwater management certification demonstrating compliance with the DuPage County Countywide Stormwater Ordinance. Additionally, the improvements will require a Dam Major Modification Permit from the Illinois Department of Natural Resources – Office of Water Resources (IDNR-OWR). It is anticipated that a separate Floodway Construction permit will not be required by IDNR-OWR but will be reviewed as part of the County permitting process. Since Fawell Dam is a flood control facility and there are historical concerns regarding flooding upstream and downstream of the dam, the proposed design and permitting processes will focus on demonstrating that the proposed improvements will not adversely impact flooding conditions.

In addition to the floodway/floodplain regulatory requirements, the proposed improvements will also need to comply with both the DuPage County and US Army Corps of Engineers (USACE) requirements associated with wetlands, Waters of the U.S., buffers, and sediment and erosion control. It is anticipated that the proposed improvements qualify for USACE Regional Permit (RP) 5, Wetland and Stream Restoration and Enhancement, which also typically requires submittal of a Stormwater Pollution Prevention Plan (SWPPP) to Kane-DuPage Soil & Water Conservation District as part of the permitting process.

1.2.3 Design Progress Report

Modifying Fawell Dam to meet fish passage and permitting criteria has proven to be more difficult to model than originally anticipated. The primary model being used, FEQ, uses a utility program called FEQUTL to create all the files necessary to describe various hydraulic structures within an FEQ model. As Fawell Dam is a very specific structure both in shape and operation methodology, a specific utility program was coded in order to model the hydraulics through the dam that incorporate the operation rules for the gates. As this function was specifically built for use with Fawell Dam, there is very little documentation available for how this function works. The team spent several months consulting with various FEQ experts in an attempt to run the model with the modified culvert. The team determined that it was necessary to identify a different, yet comparable way to model the dam.

Instead of modeling Fawell Dam as one structure with three box culverts, each with sluice gates, the dam was broken into three separate culverts, with the gates modeled separately for each individual culvert. An additional function was added to account for the expansion and contraction of water as it moves through each culvert. Since this was a different method, the modelers had to ensure that this model produced similar results as the model that had been approved by Illinois DNR. This was done by adjusting several different parameters and coefficients within the FEQUTL model as well as within the main FEQ model.

The project team has coordinated with IDNR-OWR regarding the proposed improvements, including the modeling methodology and the initial modeling results. The next step will be a second pre-application meeting to discuss the refined modeling results in preparation for an upcoming permit submittal.

The project team previously met with both DuPage County (regulatory department) and the local representative from the USACE to discuss wetland/ waters permitting. It was confirmed that the proposed improvements likely qualify for a USACE Regional Permit. The issue of indirect wetland impacts was also discussed with the County regulatory staff and some initial modeling was done to evaluate the potential impact.

1.2.4 Impact Evaluation

Post project, both IBI and fish taxa will be sampled upstream of the site and compared to historical data.

1.3 Table Item 4. Spring Brook Restoration and Dam Removal (Spring Brook Phase 2)

- Special Condition Listed Completion Date – December 2019
- Status – in the design and permitting phase

The objective of the project is to raise QHEI above its current 64, raise fIBI above its current score of 21.5 and to raise mIBI above its current score of 30.1. The project is being managed by the FPDDC and construction is being funded by a consortium of agencies including the FPDDC, the DRSCW and the Illinois State Toll Highway Authority. The project is in the second and final phase. DRSCW has budgeted $1,000,000 for this effort.

1.3.1 Site Description

The Phase 2 Project is located in unincorporated DuPage County in Blackwell Forest Preserve. The project footprint limits are entirely on Forest Preserve District of DuPage County (FPDDC) property. The project runs along Spring Brook #1. The downstream limit is approximately 400' downstream of the existing unnamed pedestrian bridge, which runs south from Mack Road. The upstream limit is Winfield Road. The project is immediately downstream of the Spring Brook #1 Stream and Wetland Restoration Project (Phase 1), which was constructed in 2015.

1.3.2 Existing Conditions

The existing stream alignment is 4,430 ft. long. The channel is incised with bank full flow around 120 cfs. The Wetlands Initiative (TWI) performed the wetland delineation of the Spring Brook # 1 Stream and Wetland Restoration Project - Phases 1 and 2. Within the Blackwell Forest Preserve, there were 19.33 acres of wetland and 17.56 acres of waters of the United States. Eighteen wetlands comprised the total wetland acres of 19.33. All on-site wetlands are under the jurisdiction of the United States Army Corps of Engineers (USACE).

1.3.3 Proposed Conditions

The proposed stream length will increase to approximately 5,680 ft with the additional sinuosity. The proposed channel will have slopes ranging from 2.5:1 to 20:1. The design bank full condition is 120 cfs . This is intended to increase the frequency of flooding within the project site to facilitate desired habitats in the floodplain. There will be 2.898 acres of USACE/ DuPage County jurisdictional wetland impacts. The wetland impacts are attributable to the excavation and fill placement for the restored stream channel meander and to replace a service road bridge and pedestrian bridge. There are 15.488 acres of impact to Waters of the US. This project is a second phase to a waters mitigation project for the Illinois State Toll Highway Authority. DRSCW has budgeted $1,000,000 for construction by December 2019.

1.3.4 Impact Evaluation

Post-project fIBI, mIBI and QHEI will be monitored and compared to historical survey data.

1.4 Table Item 5. Fullersburg Woods Dam Modification Concept Plan Development

- Special Condition Listed Completion Date – December 2016
- Status – Complete

Modification of the Fullersburg Woods dam will likely have significant public opposition. The concept plan sets out a number of scenarios to meet the water quality, habitat, TMDL and biological goals of the project. The plan also includes a framework for reaching out to stakeholders to understand their concerns and solicit their feedback so that the final design proposal can incorporate features based on their input. The plan was supplied to IEPA and will be implemented during 2017. The report can be found at http://drscw.org/wp/wp-content/uploads/2015/03/FullersburgWoodsDam_ConceptPlan_FINAL_12302016.pdf

1.5 Table Items 6 & 7. Fullersburg Woods Dam Modification and Stream Restoration

- Special Condition Listed Completion Date – December 2021
- Status – Not yet started

The project is on the Salt Creek mainstem; its objectives are to raise QHEI above its current score of 39.5, raise fIBI above its current score of 19.0, raise mIBI above its current score of 17 for approximately 1.5 river miles and to improve dissolved oxygen in the impoundment as compared to the 2007-2014 data set. The DRSCW will be collaborating with FPDDC and DuPage County Stormwater Management on this project. DRSCW budgeted $2,985,000 for this project.

Design elements recommended by the outreach framework will be identified and developed in 2017-18.

1.6 Table Item 8. Southern West Branch Physical Improvement

- Special Condition Listed Completion Date – December 2022
- Status – Concepts are being developed along with the Fawell Dam Modification Plan.

The DRSCW budgeted $500,000 for the period 2019 to 2021. This project will likely focus on enhancing the channel around the Fawell Dam following its modification.

1.7 Table Item 9. Southern East Branch Stream Enhancement

- Special Condition Listed Completion Date – December 2021
- Status – Not yet started

Work has not yet begun on this project. The DRSCW budgeted $2,500,000 for this project.

1.8 Table Item 10. QUAL2K Updates for East Branch and Salt Creek

- Special Condition Listed Completion Date – December 2023
- Status – Not yet started

Model preparation, calibration, verification, and alternative evaluation is scheduled to begin in 2019. The DRSCW budgeted $112,000 for this effort and anticipates expenditures will be made from 2019 to 2022.

In 2016, the DRSCW gathered continuous DO data, water quality grabs, flow and conducted physical geometry assessments at 3 sites on the West Branch DuPage River. The data has been used by Illinois EPA for QUAL2K modeling in support of TMDL development for segments of the West Branch DuPage River.

1.9 Table Item 11. NPS Phosphorus Feasibility Analysis

- Special Conditions Listed Completion Date – December 2021
- Status – In Planning

DRSCW contributed funding for the USGS-Wisconsin Water Science Center research project, "Developing a Framework to Advance Statewide Phosphorus Reduction Credits for Leaf Collection." This study began on 9/1/2016 and has an anticipated end date of 12/31/17. DRSCW made a $2,500 grant to the USGS research project and has budgeted $120,000 to develop the NPS nutrient feasibility analysis (inclusive of grant).

2.0 Chloride Abatement Program

2.1 Technical Workshops

Two chloride reduction workshops were held during the reporting period April 1st 2016 to March 31st 2017.

The public roads deicing workshop held on September 27, 2016 with the following agenda:

- 7:00 –- 7:25 Registration and Breakfast
- 7:25 –7:30 Welcome
  John Kawka, DuPage County DOT, Manager of Highway Operations
- 7:30 – 7:50 DuPage River Salt Creek Workgroup (DRSCW) Update
  Stephen McCracken, TCF/ DRSCW, Director of Watershed Protection
- 7:50 – 8:50 Establishing Levels of Service
  Wilf Nixon, Salt Institute, VP Science and the Environment
- 8:50 – 9:00 Break
- 9:05 – 9:35 Weather Forecasting
  Mike Adams, Wisconsin DOT, Weather Systems Program Manager
- 9:35 – 10:15 Village of Oswego's Anti-Icing Initiatives
  Jennifer Hughes, Village of Oswego, Public Works Director
- 10:15 – 10:50 New MS4 Requirements and How to Meet Them:
  Managing Pollution from your Municipal Yard – Mary Beth Falsey, DuPage County Stormwater Management, Water Quality Supervisor; John Kawka, DuPage County DOT
- 10:50 – 11:00 Break
- 11:00 – 11:25 Contractor Perspective: Communication Strategies
  Steve Pearce, Serbert, VP of Operations
- 11:25 – 11:55 Municipal Perspective: Communications Strategies
  Chris Walsh, City of Beloit, Director of Operations (Retired)
- 11:55 – 12:00 Wrap Up, Bass Pro Shop Jacket Drawing, Equipment Show

Attendance – 145 registered, 9 presenters, 11 exhibitors/staff = 165 total. All participants received a certificate of attendance. We received 94 feedback forms from participants.

The parking lots and sidewalks deicing workshop was held on September 22, 2016 with the following agenda:

- Ambient conditions and regulatory update: Stephen McCracken, The Conservation Foundation/DRSCW
- Information on developing efficient and cost-effective snow fighting operations, appropriate product selection, equipment selection, application rates, equipment calibration, ambient conditions monitoring. Presenters: Connie Fortin, Fortin Consulting and Chis Walsh, City of Beloit, WI
- Test on workshop materials.

Attendance - 68 registrations, 3 presenters, 10 exhibitors/staff = 81 total. All participants received a training certificate and participants who successfully completed the test are recognized on DuPage County Stormwater Management's Water Quality – Pollution Prevention/Good Housekeeping web page. The DRCW received 55 program evaluations from participants.

2.2 Tracking BMP Adoption

The DRSCW has attempted to track adoption of sensible salting BMPs in the program area since 2007. Monitoring ambient chloride concentrations has proven an imperfect metric for tracking efficiency trends in salt use (see section 2.4). Tracking target BMP adoption in the program area provides opportunities to: evaluate the impacts of the workshops; identify material for future workshops; form suppositions about salt use per unit of service expended inside the program area relative to levels in 2006.

In 2007, the DRSCW distributed a questionnaire to approximately 80 municipal highway operations and public works agencies to obtain baseline information about deicing practices throughout the program area. An informed baseline of deicing programs throughout the program area was formed based on the thirty-nine responses. Thirty-two public agencies responded to a similar questionnaire distributed in 2010, which indicated positive BMP adoption in local deicing practices. In 2012 and 2014, the survey generated 34 and 35 responses respectively, which further documented chloride reduction practices. A record number forty-three (43) agencies responded to the 2016 questionnaire which is positive for overall program participation but the new agency responses did appear to distort trends and create some inconsistencies.

Results showed:

- An increase in the use of dry salt (a negative outcome) - Follow up with some of the agencies reporting this shows that it is largely a result of new agencies responding to the questionnaire for the first time.
- A decrease in pre-wetted salt use (a negative outcome) - Pre-wetted salt initially showed an increase of around 15% up until 2014 when the participation rate halved, an apparent reversal of the trend observed since 2006. Follow up with some of the agencies reporting shows that it is largely a result of new agencies responding to the questionnaire for the first time and confusion on the definition of pre-wetting. The new agencies responding do present an opportunity for the Chloride Committee to investigate further expansion of the use of brine as a BMP.
- An increase in the use of all forms of calcium chloride ($CaCl_2$). The increase in liquid $CaCl_2$ is significant, roughly 30% higher.

- Results show an increase in the use of dry or pre-wetted magnesium chloride (MgCl2).
- No responders reported using liquid MgCl2 and urea in 2016.
- A few respondents reported using potassium chloride (KCl) compared to none in previous years.
- Use of calcium magnesium acetate (CMA), potassium acetate (KA), and abrasives have decreased since 2014.
- Beet juice as an additive maintained its popularity.
- The highest percentage of agencies executing some degree of anti-icing (60%) was reported in the 2016 survey (up from 50 % in 2014 and 36 % in 2007).
- Two of the responding agencies reuse vehicle wash-water for making brine solutions compared to none from the 2014 survey.
- The 2016 survey responses indicated that the 2015-16 per lane mile use of salt decreased from that in most previous years. The number of agencies applying 200-300 lbs/lm increased from 2010 to 2016. Other reported application rates have stayed relatively constant over the period. Increased rates for various storm types reported in 2016 were due to new agencies responding. Agencies applying more than 400 lbs of salt per lane mile provide opportunities for the Chloride Reduction Program to expand outreach and BMP information.
- Almost all agencies in the program area have covered, permanent salt storage facilities; however, there are still some opportunities for storage and salt handling improvements throughout the program area.
- Implementation of target BMPs, which include equipment calibration, use of weather forecasting and pavement temperature information for deicing response decisions, all increased in 2016.
- Nine out of 42 responses reported additional changes made to their program due to local deicing program workshops between 2014 and 2016.

2.3 Monitoring

Ambient monitoring of winter conductivity was carried out at 6 locations in the program area in 2014-15 and 2016-17. Conductivity is used to calculate chloride concentrations based on a relationship established by the DRSCW in 2007. Chloride concentrations are a function of applications rates, number of winter call outs, duration of winter and instream flows. The importance of understanding these variables is illustrated by comparing figures 3 and 4. The figures show the same data (summer chloride data in the West Branch on various years) but figure 4 is controlled for flow (shown as tons of chloride).

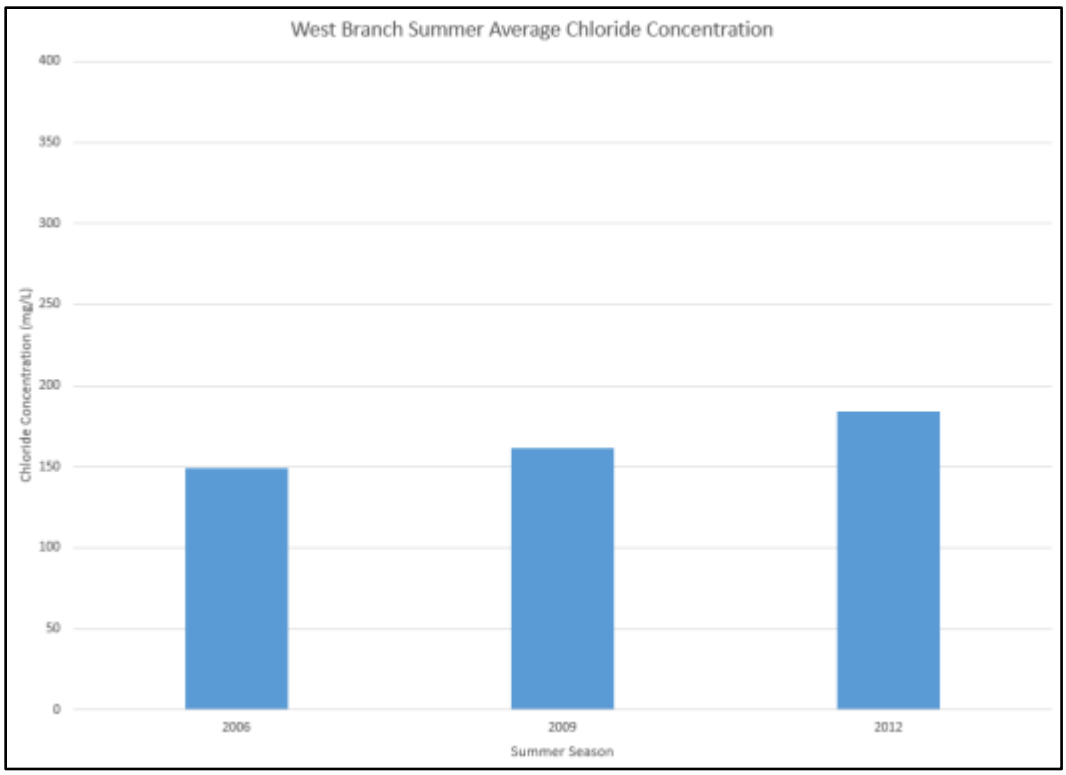


Figure 3. West Branch Chloride Concentrations Summers of 2006, 2009 and 2012

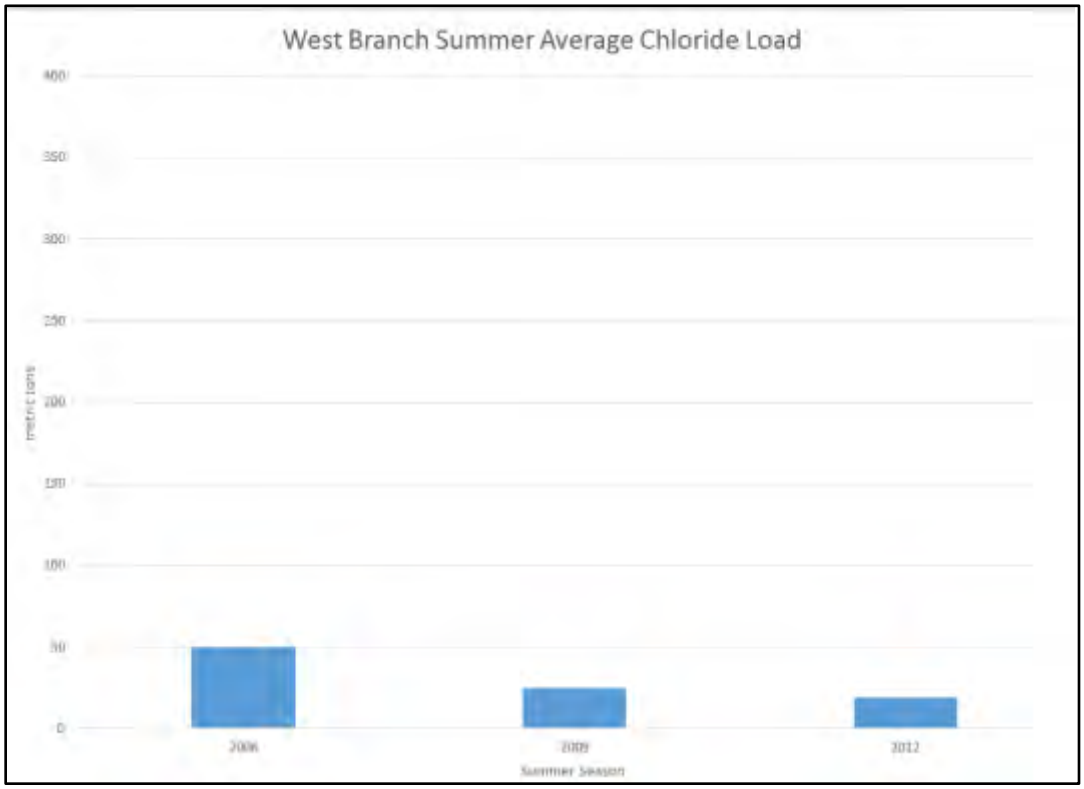


Figure 4. West Branch Summer Average Chloride Loads 2006, 2009 and 2012

3.0 Nutrient Implementation Plan

The QUAL2K models and non-point nutrient management are covered in sections 1.8 and 1.9 respectively.

3.1 Development of a Basin Wide Nutrient Trading Program

Special Condition 8.c. allows the DRSCW to develop and implement a trading program for the POTWs in the DRSCW watersheds. The nutrient trading program will allow for the reallocation of phosphorus loadings between two or more POTWs in the DRSCW watersheds as long as the following two conditions have been met:

- The loadings will not exceed those loading anticipated from the uniform application of the applicable 1.0 mg/L monthly average effluent limitation among the POTW permits in the DRSCW watersheds; and
- The loadings remove DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 IL Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 IL Adm. Code 302.203.

Special Condition 8.d. allows for the implementation of a nutrient trading program at the end of the 10-year permit cycle by allowing the Illinois EPA to modify the NPDES permits if the nutrient trading program meets the criteria detailed above.

In order to evaluate the feasibility of nutrient trading within the DRSCW watersheds, the DRSCW conducted a search to find a qualified consultant to lead the process. On November 7, 2016, a Request for Qualifications (RFQ) was distributed electronically to all DRSCW members and associate members and posted on member and industry websites. Seven (7) teams submitted qualifications: Arcadis/Troutman Sanders/Baxter & Woodman; Geosyntec/Carollo/WRI/Barnes and Thornburg/Harvey Environ-Econ; LimnoTech/Donohue and Associates; Rand Corp.; Ruekert Mielke/ERA; Strand; and TetraTech/Kieser and Assoc./Abt Assoc./Earth & Water Group. Each statement of qualifications was thoroughly reviewed by the DRSCW Projects Committee and three teams were short-listed: Arcadis/Troutman Sanders/Baxter & Woodman; Geosyntec/Carollo/WRI/Barnes and Thornburg/Harvey Environ-Econ; and TetraTech/Kieser and Assoc./Abt Assoc./Earth & Water Group. The short-listed firms prepared a detailed proposal and participated in an in-person interview with the DRSCW Projects Committee. The DRSCW is currently concluding the qualifications-based selection process by negotiating scope and fee with the chosen contractor.

The nutrient trading program will focus at minimum on point-source to point-source phosphorus trading. The proposed scope of work includes eight (8) tasks:

- Task 1. Initiate Project and Data Collection and Analysis
- Task 2. Fill Data Gaps and Data Analysis Summary
- Task 3. Selection and Calculation of Nutrient Reduction Goals
- Task 4. Evaluate the Opportunities and Cost-Effectiveness of Point Source to Non-Point Source Trading
- Task 5. Development of Nutrient Reduction Costs
- Task 6. Market Structure Recommendation
- Task 7. Develop Draft Trading Framework, Guidelines, and Templates

- Task 8. Preparation of a Nutrient Trading Program Final Report

Project work is expected to begin in late summer 2017as the Phosphorus Discharge Optimization Plans and Feasibility Studies for the POTWs in the study area become available starting in August 2017. Estimated date of completion for the basin wide nutrient trading program is 2020-2021.

Attachment 1

Draft DuPage/Salt Creek Special Condition XX.

1. The Permittee shall participate in the DuPage River Salt Creek Workgroup (DRSCW). The Permittee shall work with other watershed members of the DRSCW to determine the most cost effective means to remove dissolved oxygen (DO) and offensive condition impairments in the DRSCW watersheds.

2. The Permittee shall ensure that the following projects and activities set out in the DRSCW Implementation Plan (April 16, 2015), are completed (either by the permittee or through the DRSCW) by the schedule dates set forth below; and that the short term objectives are achieved for each by the time frames identified below:

Project Name	**Completion Date**	**Short Term Objectives**	**Long Term Objectives**
Oak Meadows Golf Course dam removal	December 31, 2016	Improve DO	Improve fish passage
Oak Meadows Golf Course stream restoration	December 31. 2017	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi
Fawell Dam Modification	December 31, 2018	Modify dam to allow fish passage	Raise fiBi upstream of structure
Spring Brook Restoration and dam removal	December 31, 2019	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
Fullersburg Woods dam modification concept plan development	December 31, 2016	Identify conceptual plan for dam modification and stream restoration	Build consensus among plan stakeholders
Fullersburg Woods dam modification	December 31, 2021	Improve DO, improve aquatic habitat (QHEI)	Raise miBi and fiBi
Fullersburg Woods dam modification area stream restoration	December 31, 2022	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi
Southern West Branch Physical Enhancement	December 31, 2022	Improve aquatic habitat (QHEI)	Raise miBi and fiBi
Southern East Branch Stream Enhancement	December 31, 2023	Improve aquatic habitat (QHEI), reduce inputs of nutrients and sediment	Raise miBi and fiBi

QUAL 2K East Branch and Salt Creek	December 31, 2023	Collect new baseline data and update model	Quantify improvements in watershed. Identify next round of projects for years beyond 2024.
NPS Phosphorus Feasibility Analysis	December 31, 2021	Assess NPS performance from reductions leaf litter and street sweeping	Reduce NPS contributions to lowest practical levels

3. The Permittee shall participate in implementation of a watershed Chloride Reduction Program, either directly or through the DRSCW. The program shall work to decrease DRSCW watershed public agency chloride application rates used for winter road safety, with the objective of decreasing watershed chloride loading. The Permittee shall submit an annual report on the annual implementation of the program identifying the practices deployed, chloride application rates, estimated reductions achieved, analyses of watershed chloride loads, precipitation, air temperature conditions and relative performance compared to a baseline condition. The report shall be provided to the Agency by March 31 of each year reflecting the Chloride Abatement Program performance for the preceding year (example: 2015-16 winter season report shall be submitted no later than March 31, 2017). The Permittee may work cooperatively with the DRSCW to prepare a single annual progress report that is common among DRSCW permittees.

4. The Permittee shall submit an annual progress report on the projects listed in the table of paragraph 2 above to the Agency by March 31 of each year. The report shall include project implementation progress. The Permittee may work cooperatively with the DRSCW to prepare a single annual progress report that is common among DRSCW permittees.

5. The Permittee shall develop a written Phosphorus Discharge Optimization Plan. In developing the plan, the Permittee shall evaluate a range of measures for reducing phosphorus discharges from the treatment plant, including possible source reduction measures, operational improvements, and minor low cost facility modifications that will optimize reductions in phosphorus discharges from the wastewater treatment facility. The permittee's evaluation shall include, but not necessarily be limited to, an evaluation of the following optimization measures:
   a. WWTF influent reduction measures.
      i. Evaluate the phosphorus reduction potential of users.
      ii. Determine which sources have the greatest opportunity for reducing phosphorus (e.g., industrial, commercial, institutional, municipal, and others).
         1. Determine whether known sources (e.g., restaurant and food preparation) can adopt phosphorus minimization and water conservation plans.
         2. Evaluate implementation of local limits on influent sources of excessive phosphorus.

b. WWTF effluent reduction measures.

i. Reduce phosphorus discharges by optimizing existing treatment processes without causing non-compliance with permit effluent limitations or adversely impacting stream health.

1. Adjust the solids retention time for biological phosphorus removal.
2. Adjust aeration rates to reduce DO and promote biological phosphorus removal.
3. Change aeration settings in plug flow basins by turning off air or mixers at the inlet side of the basin system.
4. Minimize impact on recycle streams by improving aeration within holding tanks.
5. Adjust flow through existing basins to enhance biological nutrient removal.
6. Increase volatile fatty acids for biological phosphorus removal.

6. Within 24 months of the effective date of this permit, the Permittee shall finalize the written Phosphorus Discharge Optimization Evaluation Plan and submit it to IEPA. The plan shall include a schedule for implementing all of the evaluated optimization measures that can practically be implemented and include a report that explains the basis for rejecting any measure that was deemed impractical. The schedule for implementing all practical measures shall be no longer than 36 months after the effective date of this permit. The Permittee shall implement the measures set forth in the Phosphorus Discharge Optimization Plan in accordance with the schedule set forth in that Plan. The Permittee shall modify the Plan to address any comments that it receives from IEPA and shall implement the modified plan in accordance with the schedule therein.

   Annual progress reports on the optimization of the existing treatment facilities shall be submitted to the Agency by March 31 of each year beginning 24 months from the effective date of the permit.

7. The Permittee shall, within 24 months of the effective date of this permit, complete a feasibility study that evaluates the timeframe, and construction and O & M costs of reducing phosphorus levels in its discharge to a level consistently meeting a limit of 1 mg/L, 0.5 mg/L and 0.1 mg/L utilizing a range of treatment technologies including, but not necessarily limited to, biological phosphorus removal, chemical precipitation, or a combination of the two. The study shall evaluate the construction and O & M costs of the different treatment technologies for these limits on a monthly, seasonal, and annual average basis. For each technology and each phosphorus discharge level evaluated, the study shall also evaluate the amount by which the Permittee's typical household annual sewer rates would increase if the Permittee constructed and operated the specific type of technology to achieve the specific phosphorus discharge level. Within 24 months of the effective date of this Permit, the Permittee shall submit to the Agency and the DRSCW a written report summarizing the results of the study.

8. Total phosphorus in the effluent shall be limited as follows:

    a. If the Permittee will use chemical precipitation to achieve the limit, the effluent limitation shall be 1.0 mg/L on a monthly average basis, effective 10 years after the effective date of this permit unless the Agency approves and reissues or modifies the permit to include an alternate phosphorus reduction program pursuant to paragraph c or d below that is fully implemented within 10 years of the effective date of this permit.
    b. If the Permittee will primarily use biological phosphorus removal to achieve the limit, the effluent limitation shall be 1.0 mg/L monthly average to be effective 11 years after the effective date of this permit unless the Agency approves and reissues or modifies the permit to include an alternate phosphorus reduction program pursuant to paragraph c or d below that is fully implemented within 11 years of the effective date of this permit.
    c. The Agency may modify this permit if the DRSCW has developed and implemented a trading program for POTWs in the DRSCW watersheds, providing for reallocation of allowed phosphorus loadings between two or more POTWs in the DRSCW watersheds, that delivers the same results of overall watershed phosphorus point-source reduction and loading anticipated from the uniform application of the applicable 1.0 mg/L monthly average effluent limitation among the POTW permits in the DRSCW watersheds and removes DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 IL Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 IL Adm. Code 302.203.
    d. The Agency may modify this permit if the DRSCW has demonstrated and implemented an alternate means of reducing watershed phosphorus loading to a comparable result within the timeframe of the schedule of this condition and removes DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 IL Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 IL Adm. Code 302.203.

9. The Permittee shall monitor the wastewater effluent, consistent with the monitoring requirements on Page 2 of this permit, for total phosphorus, dissolved phosphorus, nitrate/nitrite, total Kjeldahl nitrogen (TKN), ammonia, total nitrogen (calculated), alkalinity and temperature at least once a month. The Permittee shall monitor the wastewater influent for total phosphorus and total nitrogen at least once a month. The results shall be submitted on NetDMRs to the Agency unless otherwise specified by the Agency.

10. The Permittee shall submit a Nutrient Implementation Plan (NIP) for the DRSCW watersheds that identifies phosphorus input reductions by point source discharges, non-point source discharges and other measures necessary to remove DO and offensive condition impairments and meet the applicable dissolved oxygen criteria in 35 IL Adm. Code 302.206 and the narrative offensive aquatic algae criteria in 35 IL Adm. Code 302.203. The NIP shall also include a schedule for implementation of the phosphorus input reductions and other measures. The Permittee may work cooperatively with the DRSCW to prepare a single NIP that is common among DRSCW permittees. The NIP shall be submitted to the Agency by December 31, 2023.

Attachment 2

Oak Meadows Dam Removal and Stream Restoration Project Summary

The Oak Meadows Dam Removal and Stream Restoration Project was completed in 2016 as part of a larger project to improve playable areas of a golf course at the site by relocating and regrading the course and reducing the number of holes from 27 to 18. The information supplied here focuses on the extensive river naturalization portion of the project.

The 2010 stressor analysis for Salt Creek found the project site to be deficient in pool and riffles, riparian vegetation, gravel substrates and channel form. Practices implemented were designed to address each of these deficiencies, function inside the sites urban flow regime and integrate fully into the golf course features. The final design plans showing features scheduled for removal and for construction were supplied as attachment 3 in the 2016 report. The management practices implemented at the site are summarized in table A2.1 below and in maps 1 and 2 of this attachment. The practices put in place aimed to reduce modified stream characteristics(see map 1) and increase natural stream characteristics (see map 2). The imagery in map 2 is from early 2016 and shows the riparian vegetation and wetlands still under construction.

Practice	Units	Notes
Dam Removal	2	Improve DO and habitat values in impoundment
A-Jacks Removal	6,175 linear feet	Allow for increase in bank habitat values
Sheetpile Removal	1,190 linear feet	Allow for increase in bank habitat values
Soil Lifts Installed	7,530 linear feet	Allow for increase in bank habitat values
Bank Protection Fabric Installed	13,740 square yards	Erosion Control
Cobble Installed	9,400 Tons	Increase steam bed habitat values
Boulders Installed	105 Tons	Increase steam bed habitat values
Root Wads Installed	3,765 linear feet	Allow for increase in bank habitat values
Riparian Enhancement (including wetlands)	42.2 acres	Increase buffer/riparian habitat value
Other Natural Areas Restoration including wetlands	103 acres	Increase upland habitat value
Total wetlands (all)	38.2 acres	Increase habitat value

Table A2.1. Summary of surface water practices implemented as part of the Oak Meadows project.

Project History and Identification.

A time line of project activities is supplied in this section. The project was first identified as a basin priority by the DRSCW's 2009 QUAL2K model for dissolved oxygen in Salt Creek. The model identified two principle DO sags in the basin, one in the impoundment upstream of the Fullersburg Woods Dam and the second in the impoundment upstream of the Oak Meadows Dam. The DRSCW targeted dam removal as a cost effective means to improve in-stream DO as part of the group's adaptive management approach to TMDL implementation. At that time, the dam's owner (Forest Preserve District of DuPage

County or FPDDC) had no interest in modifying the site and the DRSCW had no implementation funding to pursue the project.

The DRSCW's 2010 biological stressor analysis assigned the site a priority listing of 3, making it a mid-ranking site. However, after a management change at the Oak Meadows Golf Club the FPDDDC seriously contemplated a substantial modification of the course to decrease the number of playable days lost due to flooding (the preserve operates as a public golf course). The FPDDC and the DRSCW collaborated to develop an engineering plan for the location in 2012. The objectives of the masterplan were to maximize both the golf utility and the aquatic habitat outputs of the site.

The final design shrank and changed the golf course footprint to reduce flooding impacts on playable surfaces, removed bank armor and two low head dams and created waterway features to remedy shortcomings identified by the QHEI evaluations (2007, 2010 and 2013). Benefits of the project include a more exciting and playable course and expanded and naturalized river and wetlands that support increased aquatic biodiversity.

The project's construction plans formed attachment 3 of the 2016 report. Table 2 in the report lists the timeline of activities carried out by the project team. Of particular note:

- The project necessitated the redirection of Salt Creek's flow to allow excavation and construction to take place in dry conditions.

- The dam at river mile 22.7 was removed as was a second structure at river mile 23.4 that was identified during preliminary fieldwork carried out by the DRSCW in 2012.

- A large section of A-Jacks and sheet pile walls were removed prior to starting in-channel work. While armoring stabilized the banks, it provided minimum value for habitat and pollutant assimilation water quality benefits. In addition, after the dam removals, many A –Jacks were left above the ordinary high water mark.

- Banks were re-graded and stabilized. Bioengineered stabilization methods that provide enhanced water quality benefits utilized in the project include surface fabric bank treatment, fabric encapsulating soil (FES) lifts with log/rock toe. The log/rock toe practice was applied at and below the water line and provides scour protection at sensitive river bank areas.

- . To increase stream bed diversity, which pre-project was dominated by muck substrates, several sections of gravel were added. Increasing coarse substrates is considered critical to increasing the biodiversity of lotic macroinvertebrates which DRSCW surveys have found to be lacking at the site.

Attachment 2

Figure 1. Pre-project Oak Meadows Dam. Note the sheet piling on the right bank as we look towards the dam, and the A-Jacks on the left bank as we look towards the dam.

Figure 2. Post-project Oak Meadows location. Sheet piling and A-Jackswere removed and banks have been graded. Native vegetation was planted and gravel substrates created.

Attachment 2

Figure 3. "The Island" looking upstream pre-project. Note the armored banks and the mud substrates.

Figure 4. "The Island" looking upstream post-project. Armoring was removed and replaced on the outside banks by root wads. Note the grading on the inside bank. Gravel beds have replaced muck beds.

Attachment 2

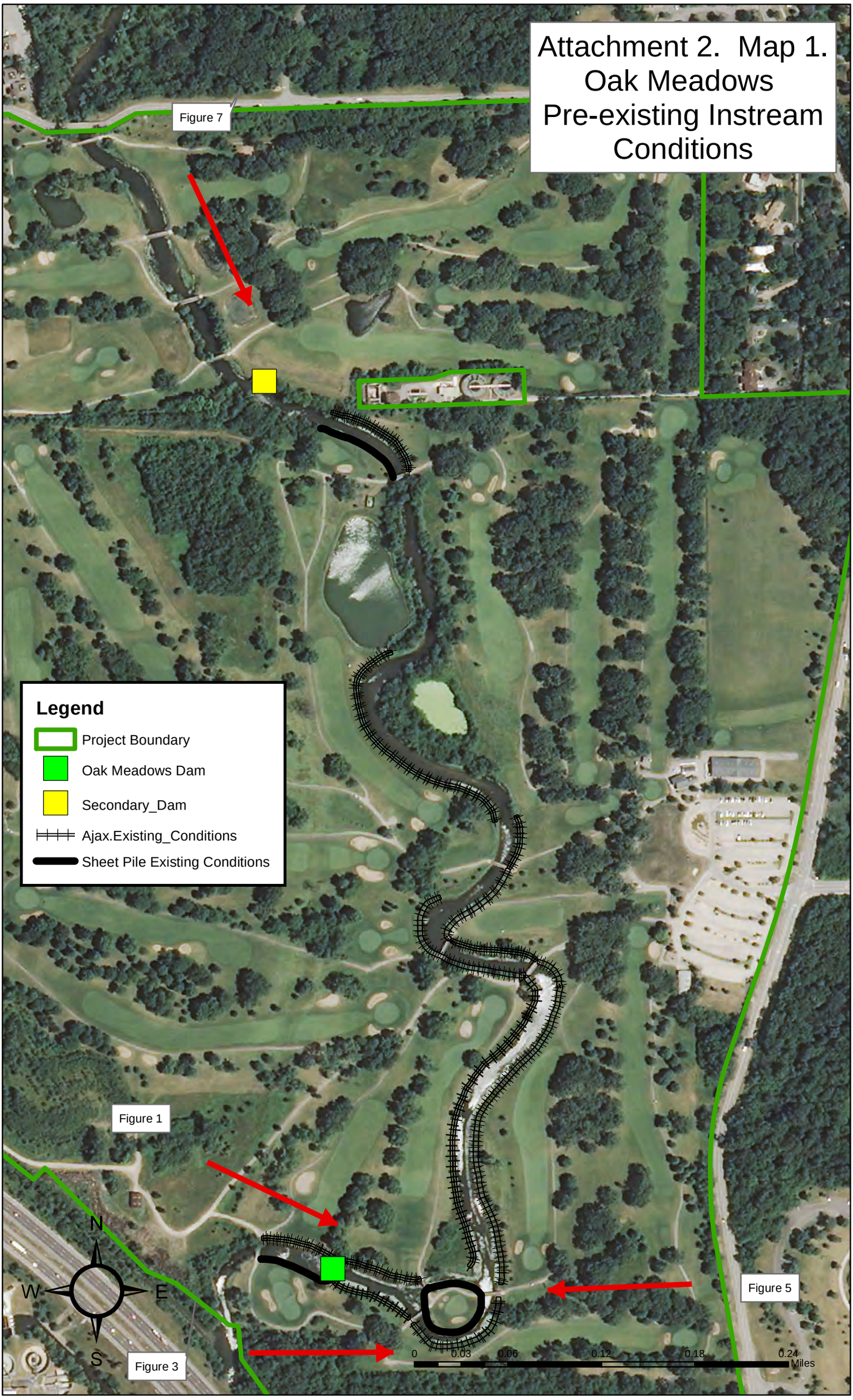
Figure 5. "The Island" pre-project looking downstream towards viewpoint for images 3 and 4.

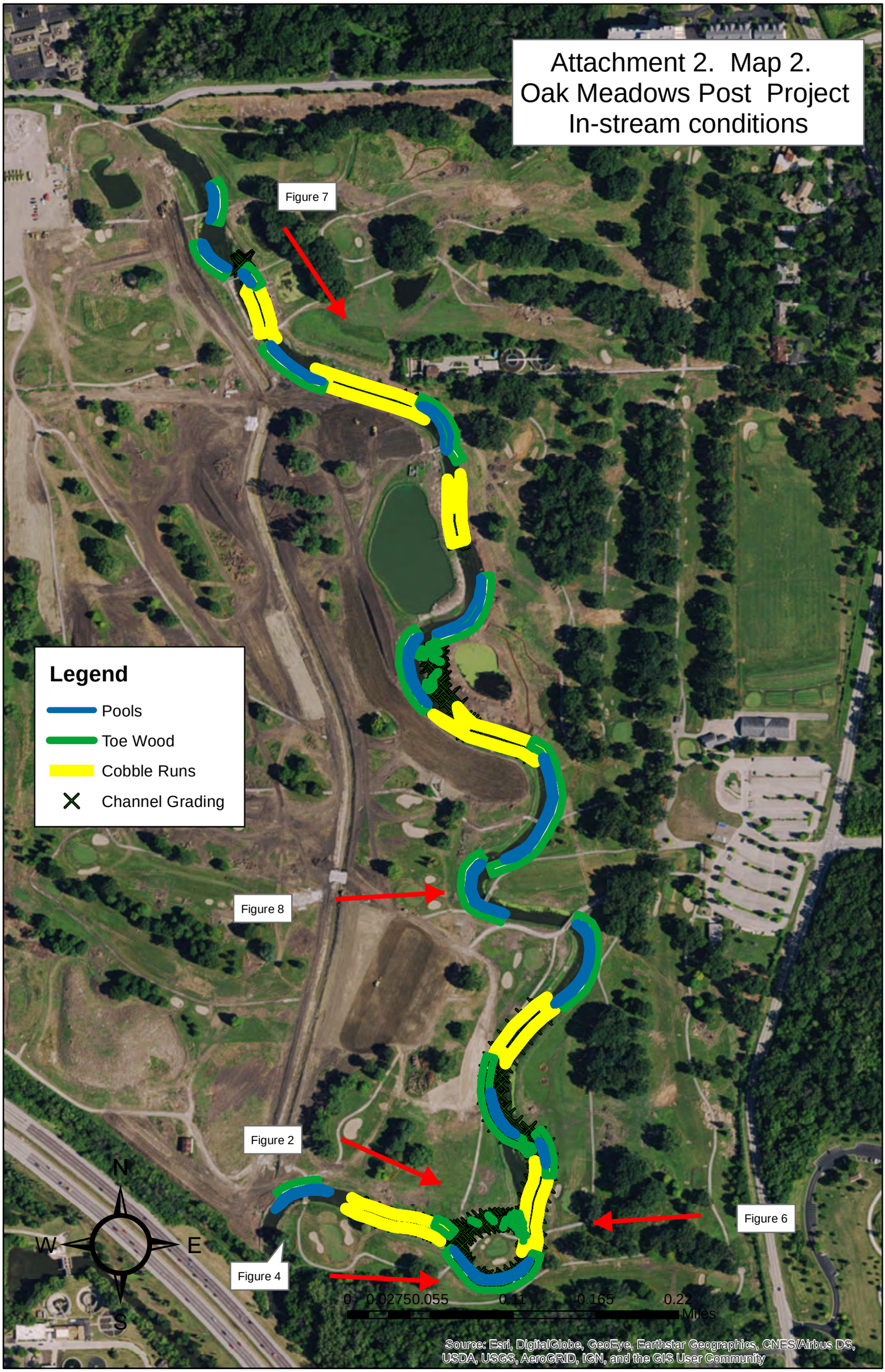
Figure 6. "The Island" post-project looking downstream, the graded banks, toe wood and riparian vegetation are plainly visible.

Attachment 2

Figure 7. During Construction. Looking downstream (south) from the diversion dam at the northern end of the project (near Elizabeth Drive) prior to flow being reintroduced. The diversion channel is on the right of the image. The river channel is on the left of the image with gravel runs/beds and graded stream banks under construction.

Figure 8. During Construction. Looking east across Salt Creek after flow was reintroduced. Note the extensive naturalized riparian area on the eastern (far) bank.


Attachment 2. Map 1.
Oak Meadows
Pre-existing Instream
Conditions
Figure 7
Legend
Project Boundary
Oak Meadows Dam
Secondary_Dam
Ajax.Existing_Conditions
Sheet Pile Existing Conditions
Figure 1
N
W
E
S
Figure 3
Figure 5
0
0.03
0.06
0.12
0.18
0.24
Miles


Attachment 2. Map 2.
Oak Meadows Post Project
In-stream conditions
Figure 7
Figure 8
Figure 2
Figure 4
Figure 6
Legend
Pools
Toe Wood
Cobble Runs
Channel Grading
N
W
E
S
0 0.02750.055 0.11 0.165 0.22
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Attachment 3

WEST BRANCH OF THE DUPAGE RIVER, NAPERVILLE, IL

Fawell Dam Fish Passage Feasibility Analysis

TECHNICAL MEMO, AUGUST 2016

PREPARED FOR:

Dupage River Salt Creek Workgroup
10 S 404 Knoch Knolls Road
Naperville, IL 60565

inter·fluve inc.

Table of Contents

1 Introduction

In an effort to assess the feasibility of modifying Fawell Dam for fish passage, Dupage County constructed a 1-dimensional hydraulic model for evaluating potential water velocities and depths along the West Branch DuPage River under proposed culvert scenarios. This report briefly describes Inter-Fluve's (IFI's) review of that model, as well as the results and implications of those modeling results. Additionally, it describes possible changes in channel geomorphology upstream of the dam if Fawell Dam is modified.

PROJECT AREA

Fawell Dam is located on the West Branch DuPage River 8 miles upstream of the confluence with the East Branch DuPage River. The dam consists of three approximately 10 ft high by 10 ft wide concrete box culverts in parallel. Gates are located on the upstream face of each culvert to provide downstream flood control. The inverts of the 80 ft long box culverts are elevated above the historic thalweg, and thus, impound water and sediment upstream.

PROJECT GOALS AND OBJECTIVES

The primary goal for the project is to allow fish passage through Fawell Dam. Previous fish surveys, together with analysis of hydraulic conditions within the dam culverts, have suggested that the dam is likely a barrier to upstream migration for some species of fish. Successful fish passage depends on variables such as water velocity, depth, distance between resting positions for the fish, and each fish's ability to swim against the current. IFI's Data Collection Technical Memorandum (September 30, 2014) outlined (1) physical habitat requirements that limit fish passage, and (2) hydrologic characteristics at the dam during critical fish passage periods. Initially, the design team proposed lowering one of the culverts to improve fish passage, but further analysis makes it apparent that lowering two of the culverts would produce better fish passage conditions. In this document, water depths are examined and velocity data output from the hydraulic model are compared to sustainable swim velocities of local fish species to evaluate the potential for passage if one or two culverts are lowered.

In addition to summarizing fish passage requirements, our previous memo also described a preliminary data collection effort and analysis of the geomorphology in the reach encompassing Fawell Dam between the West Ogden Ave Bridge and the West Drive Bridge. The area between the dam and just below the West Drive Bridge is typically backwatered during low flow periods. In this memorandum, the field data from representative cross sections (Figure 1) are incorporated into a description of the likely process and potential outcomes of geomorphic adjustment following dam modification.

Figure 1. Site map of the Fawell Dam and impoundment. The 1939 channel boundaries are shown (yellow) to demonstrate the relative area of backwater due to the dam. Stations (in red) are shown for reference to the longitudinal profile. Cross-sections (blue) are IFI survey sections from 2014 field study.

2 Fish Passage and Hydraulics

FISH PASSAGE CRITERIA

Fish sampling results between 1983 and 2012 indicated that some fish species that are present below Fawell Dam may not be present in the reach above the dam and that some species present downstream of the dam may not be present anywhere upstream of the dam (Table 1). Given the high velocities observed within the culverts through the dam, it is likely that the absence or very low abundance of these species upstream of the dam is due in part to the inability of fish to move upstream through the dam. Even for species that occur both upstream and downstream of the dam, the dam is likely limiting genetic mixing between populations, and reducing the likelihood of successful recolonization if a population is eliminated in a reach. Therefore, improving conditions at the dam such that fish may pass through it is expected to increase species diversity and abundance throughout these reaches of the river and make fish populations more sustainable over time.

When considering criteria for fish passage, water velocity and water depth are critical variables. If water is shallower than the depth of the fish's body, the fish cannot generate the maximum forward force possible with its tail stroke. Even if the water is slightly deeper than the body depth, turbulence due to swimming can result in locally shallower depths near the fish. Therefore, a depth of at least 1.5 times the depth of the fish is recommended. Ensuring deeper water also reduces risk of fin and gill abrasion and minimizes loss to predation. Conservative targets for water depth suitable for fish passage can be set based on the larger individuals within the larger, native, deeper bodied species found in the river, such as the catfish, carpsuckers, and gizzard shad. The deepest water in any cross section should be at least 8 inches deep to satisfy depth criteria for most fish.

Table 1. Fish species present in the West Branch DuPage River between 1983 and 2012. Species in italics are those found downstream of Fawell dam but not in the 3.6 mile reach immediately upstream of Fawell Dam. Species in bold have been found downstream of Fawell dam but not anywhere upstream of dam.

Hornyhead chub	*Quillback carpsucker*	Sand shiner	Stonecat madtom
Central stoneroller	*Pumpkinseed*	White sucker	Black crappie
Bigmouth shiner	*Western mosquitofish*	Common carp	Smallmouth bass
Blackstripe topminnow	*Channel catfish* Gol	dfish	Largemouth bass
Shorthead redhorse	*Brown bullhead* Gol	den shiner	Green Sunfish
Emerald shiner	*Johnny darter*	Creek chub	Bluegill sunfish
Largescale stoneroller	Northern pike	Spotfin shiner	Orangespotted sunfish
Flathead catfish	Yellow bass	Bluntnose minnow	Central mudminnow
Tadpole madtom	Gizzard shad	Fathead minnow	Grass pickerel
White perch	White crappie	Yellow bullhead	Redear sunfish
Rock bass	River carpsucker	Black bullhead	Yellow perch
Longear sunfish			

Source: DRSCW

Velocity criteria for fish passage are not very well established for most non-game fish. "Critical swimming speeds" have been determined in laboratory swim tunnels for some of the fish found in the West Branch of the DuPage River. Many of the species have not been studied in detail, but other species within the same genus or at least within the same family have been studied. Many of these studies have

been summarized and compiled in a fish swim capability table developed by the US Forest Service for the Fish Xing program (www.stream.fs.fed.us/fishxing). For many of the centrarchids (sunfish and black bass) and cyprinids (minnows, shiners, stonerollers, and chubs), prolonged swim speeds are reported in the Fish Xing swim table in the range of 30-45 cm/s (1-1.5 ft/s).

Swimming speeds determined within laboratory swim tunnels have been found to not accurately represent velocities that fish can swim when ascending real raceways, at least for some species (Peake, 2004). Therefore, it has been suggested that critical swim speeds determined in laboratory swim tunnels not be used to set fish passage water velocity criteria if more relevant information is available for particular species. The most relevant studies available at this time are those conducted by Peake (2004 and 2008). Peake tested success in ascending a 50 meter raceway against flow velocities that ranged from 35 cm/s to 120 cm/s measured 8 cm from the raceway bottom. Results of such studies are only available for smallmouth bass, northern pike, walleye, and white suckers. Peake found that for northern pike and walleye, the fraction of individuals that successfully ascended the raceway was significantly lower at 120 cm/s than at 100 cm/s and lower, but for white suckers and smallmouth bass, there was no significant decrease in success rate against velocities of 120 cm/s.

Northern pike are often used as a target species in fish passage projects in waters where they occur due to their relatively poor swimming capability for durations that exceed more than a few seconds. They are also known to be migratory during early spring as they swim from larger rivers up through tributaries to wetlands where they spawn. Peake (2008) found that approximately 80% of individuals tested were successful ascending against velocities of up to 100 cm/s, but only 33% of individuals were successful ascending average velocities of 120 cm/s.

It is important to note that the velocities reported above from the Peake (2004 and 2008) studies were measured only 8 cm from the raceway bottom. Velocities measured at 60% of depth, which are typically close to average velocities, were also measured. For a flow with velocity of 100 cm/s 8 cm from the bottom, the 60% depth velocity was 123 cm/s. For a flow with a velocity of 120 cm/s 8 cm from the bottom, the 60% depth velocity was 148 cm/s. Therefore, an appropriate target average velocity throughout the stream cross section for northern pike and walleye would be approximately 123 cm/s (4 ft/s), and an appropriate target average velocity for smallmouth bass, and white suckers is approximately 148 cm/s (4.9 ft/s).

Smaller fish tend to be weaker swimmers than larger fish. However, small fish can take advantage of the fact that velocities are much lower in boundary layers adjacent to rocks, and they can utilize resting places behind rocks and in the interstitial spaces between rocks in natural streams. Two species in the target list that may not be able to use the boundary layer near the stream bottom are the blackstripe topminnow and mosquitofish, which tend to swim near the surface of the water. Further analysis of velocities within the zone near the stream bottom (the "boundary layer") is presented in the hydraulics section of this memo.

Migration Season

To ensure fish passage through the dam, depth, velocity and distance requirements should not be exceeded for as many of the native fishes present in the river as possible during the spawning or

migration period. Creating fish passage during other times of the year may be desirable as well, but passage during the migratory window should allow populations up- and downstream to mix. Most of the fishes within the West Branch of the DuPage River will be migrating between March and the end of July. For a few of the species, spawning may continue into the first couple weeks of August. Many fishes will likely be seeking refuge during higher flows rather than migrating, and at extremely low discharges, fish will be seeking refuge in pools rather than migrating. Therefore, hydraulic conditions within a structure during extreme high and low flows are not important if refuge areas are available.

HYDROLOGY

IFI's data collection memorandum (2014) summarizes the existing hydrologic conditions along the West Branch DuPage River at Fawell Dam, including peak flow and partial flood quantiles, the impact of Fawell Dam storage, and flow duration statistics for daily flows. Flow statistics were estimated with peak flow and average daily flow data from the USGS gages at Warrenville (05540095) and at Naperville (05540130). The Warrenville gage has been in operation for 45 years, from 1969 to 2014. Although not always true for urban streams (e.g., Annable et al. 2010), bankfull conditions typically correspond to the 1.5 to 5 year recurrence interval flood. We estimate that for the West Branch DuPage River at Fawell Dam, these flood flows range between 1955 and 3925 cfs.

Table 2. Partial duration flood series recurrence intervals at the Warrenville gage and at the Fawell Dam. The Fawell Dam flows were adjusted using the ratio of drainage areas.

Recurrence Interval (years)	Discharge (cfs)	
	Warrenville	Fawell Dam
0.2	630 7	59
0.3	795 9	57
0.5	1,100 1,	325
0.75	1,332 1,	604
1	1,500 1,	808
1.5	1,623 1,	955
2	1,764 2,	125
5	3,259 3,	925

However, although floods dictate channel morphology in most channels, their duration is short enough that they do not prevent movement of fishes throughout river systems over the long term. Fish tend to move during periods of more typical (non-flood) flows, and therefore, these typical flows are usually the target for fish passage analyses. For many fishes, ensuring fish passage for 80-90% of all flow conditions will sufficiently eliminate the barrier as an impediment to healthy fish communities. For the fishes that utilize the West Branch DuPage River, the period between March and July is generally when they seek optimal spawning and rearing habitats. If it is feasible to modify the Fawell Dam, we suggest targeting fish passage for all flows between the 10% and 95% exceedance levels, if possible, during this migratory period. The flow duration analysis indicated that these target flows are between 42 and 397 cfs (Table 3).

Table 3. Flow-duration values at Fawell Dam based on adjusting average daily discharge data at the Warrenville gage. The March-July time window represents the period when most fishes that migrate are moving to spawning areas in the West Branch DuPage River. This is the most critical time to ensure fish passage.

% Time Exceeded	Annual	March-July
1% 1,	196	1,269
2% 8	56	975
5% 4	80	611
10% 2	97	397
20% 1	63	238
30% 1	28	178
40% 1	01	143
50% 82		117
60% 66		98
70% 54		80
80% 43		65
90% 34		51
95% 30		42

HYDRAULICS

A 1-dimensional hydraulic model was developed by Dupage County for existing and proposed conditions using the U.S. Army Corps of Engineers (USACE) Hydraulic Engineering Center's River Analysis System (HEC-RAS 5.0; USACE 2015). The model includes data from previous models produced for regional flood studies, and local data collected at the dam (e.g., culverts, spillway, downstream riffle) and within the impoundment. For the proposed conditions, which include lowering one or two culverts, the upstream channel was modified to match anticipated channel adjustments following culvert modification. Inter-Fluve reviewed the geometry files that represent existing and potential modification scenarios, and though refinements to the geometry files will be important during final design, we determined that they reflect a conservative representation of conditions in the vicinity of the dam.

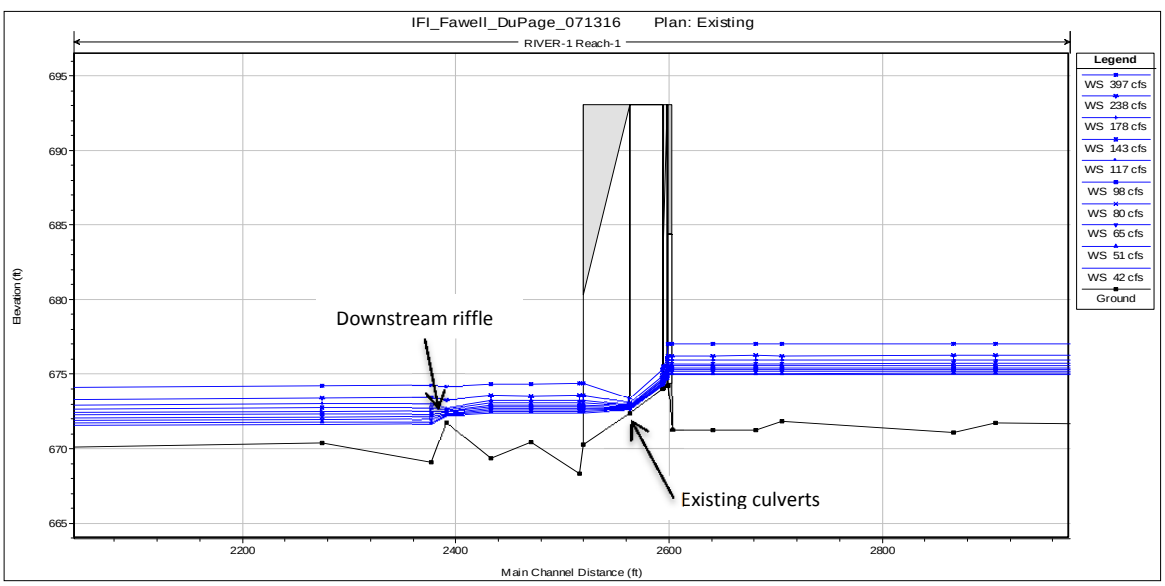


Figure 2. Existing streambed profile and water surface profiles through and adjacent to Fawell Dam.

Inter-Fluve modified the set of flow rates analyzed in the model to correspond to the statistical exceedance values shown in Table 3. We also interpolated extra cross sections between the cross sections provided to allow for greater precision in determining location and values of critical hydraulic parameters. For non-flood flows, lowering the culverts reduces velocities within the culverts at Fawell Dam and slightly increases velocities upstream, relative to existing conditions. Since velocities upstream of the culverts generally remain less than 1 ft/s for the target range of flows, we will focus on conditions near the culverts and at the downstream riffle.

Under existing conditions within the culverts, the model predicts average flow velocities from 7.8 ft/s at 42 cfs to13.5 ft/s at 397 cfs (Figure 3). No part of this range is suitable for passage of the target fish species. Lowering one culvert reduces average velocities to between 2.8 and 9.4 ft/s at 42 and 397 cfs, respectively, and the velocity is less than the target of 4 ft/s at flows less than 65 cfs, which represents only 20% of the time (Figure 4). Lowering two culverts further lowers velocities to between 1.6 and 8.0 ft/s, and the velocity is less than the target of 4 ft/s at all flows less than 143 cfs, which is expected 60% of the time (Figure 5).

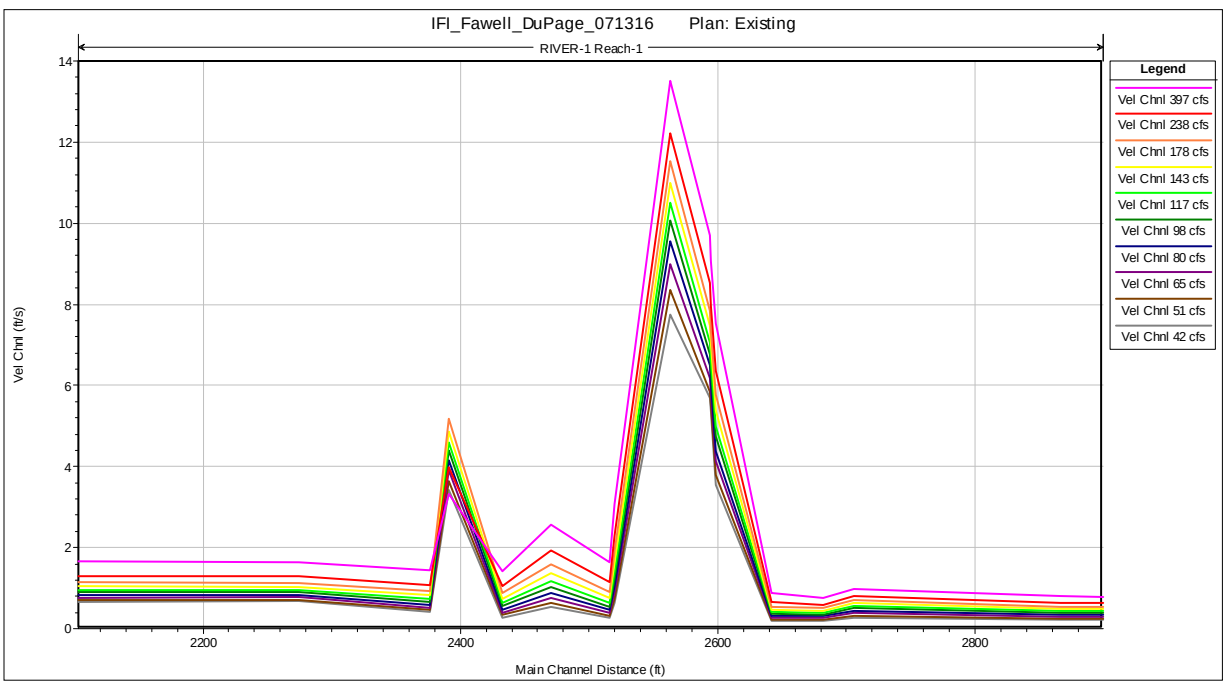


Figure 3. Flow velocities under existing conditions.

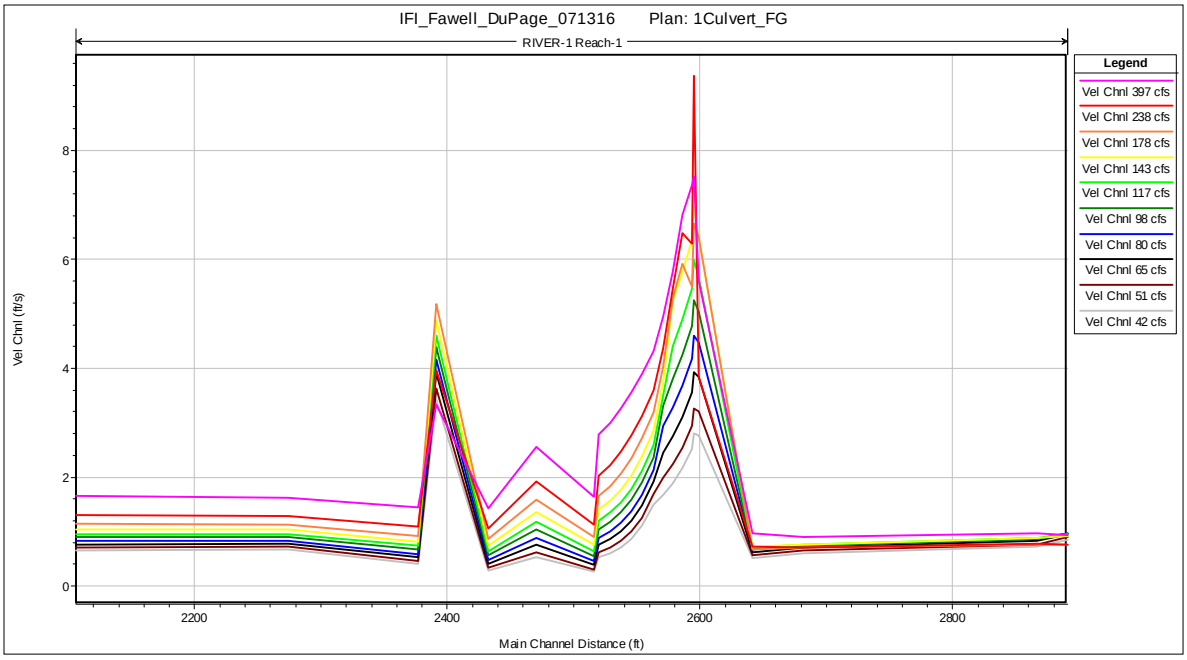


Figure 4. Flow velocities with one Fawell Dam culvert lowered.

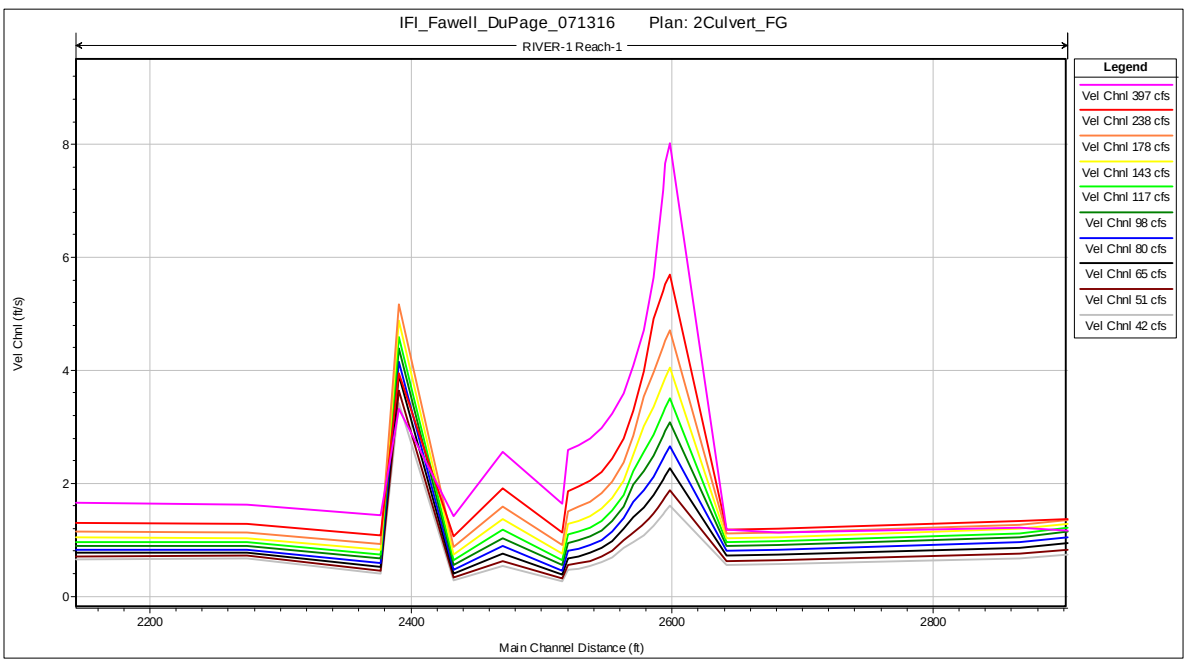


Figure 5. Flow velocities with two Fawell Dam culverts lowered.

While these results suggest that target velocity conditions will not be met 80% of the time, as targeted, for the scenarios in which the culverts are lowered, the peak velocities are predicted at the upstream end of the culvert. If it is possible to flatten the culvert slope, these velocities may be further reduced. This possibility will be explored during final design.

Channel depths within the culvert increase under proposed conditions, from an existing minimum of 0.25 ft to a minimum of 2.0 ft with two culverts dropped, and upstream depths decrease slightly (Figures 6-8). Water is relatively deep within the culverts for the proposed modification scenarios, primarily due to the backwater effect from the downstream riffle.

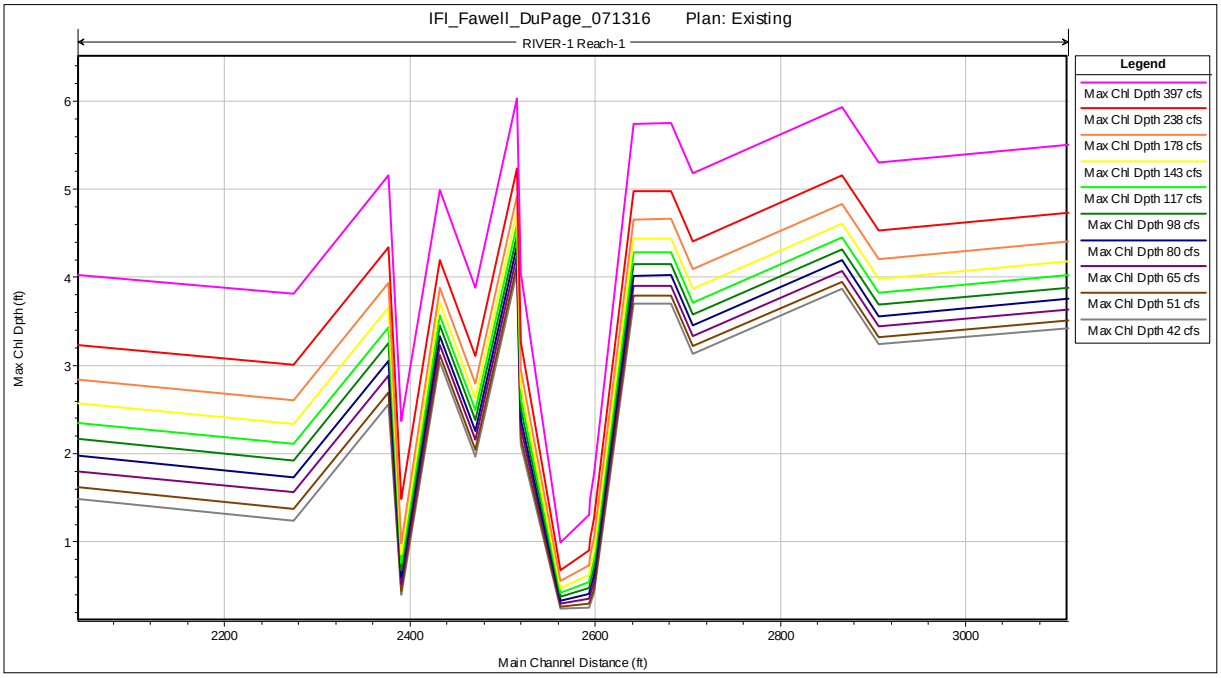


Figure 6. Maximum flow depths under existing conditions.

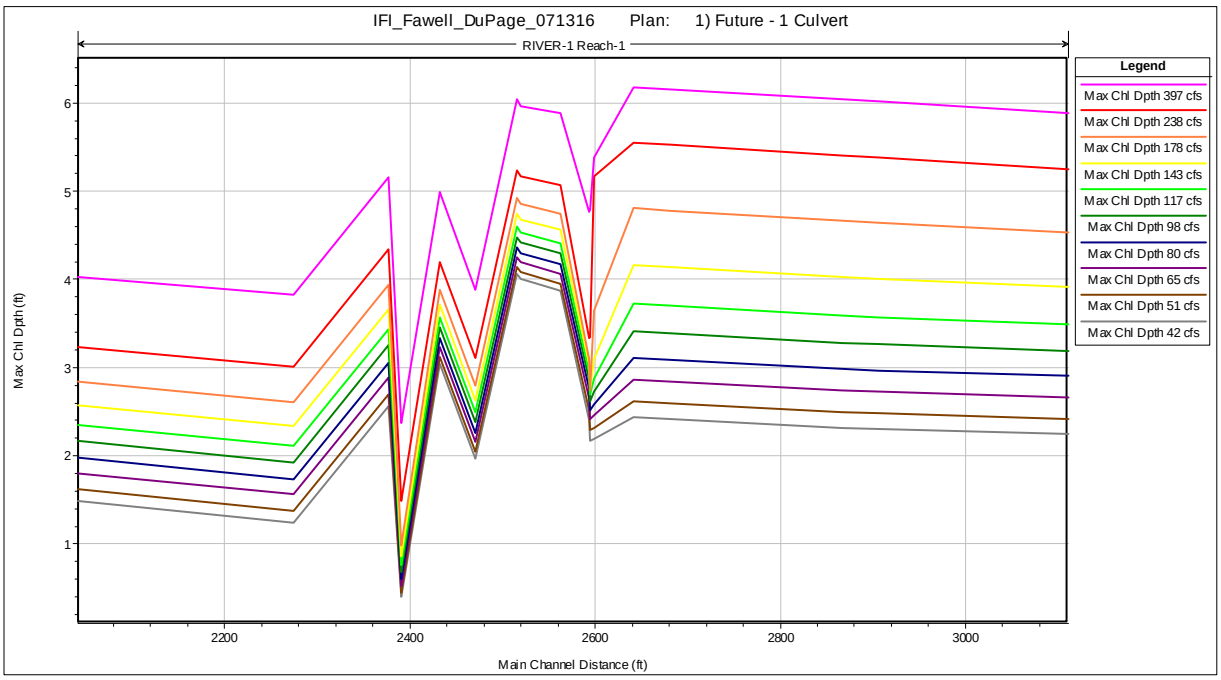


Figure 7. Maximum flow depths with one culvert lowered.

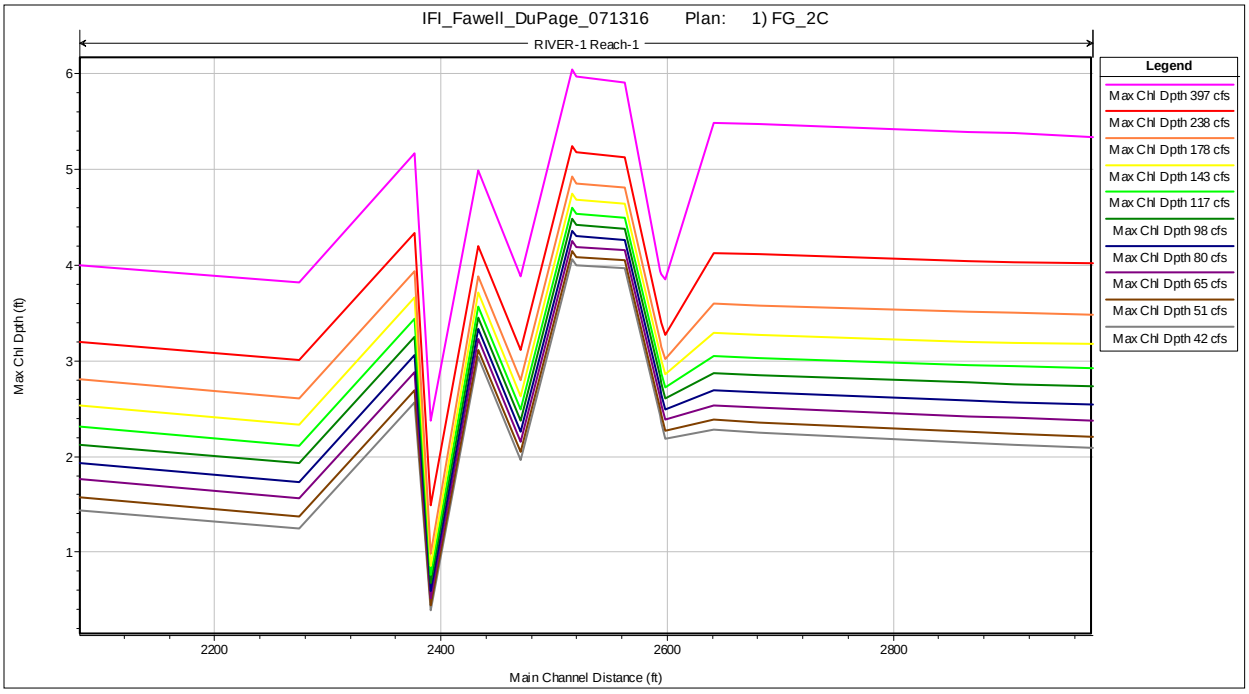


Figure 8. Maximum flow depths with two culverts lowered.

The downstream riffle does not currently exhibit velocity and depth conditions that support fish passage for the majority of flow conditions. For flows less than 65 cfs, water depth is less than 6 inches, which may prevent larger fish from passing. For flows between 80 cfs and 178 cfs, velocity across the top of the riffle exceeds 4 ft/s, which may inhibit slower fish that are not small enough to benefit from reduced velocities in the boundary layer. For this reason, a couple of scenarios were explored for which the riffle crest was lowered. Under existing conditions, the riffle is roughly 1.3 ft above an average bed height based on up- and downstream profile data. The riffle height was reduced to 1 ft and 0.5 ft by lowering the elevation 0.3 ft and 0.8ft. The model was run with two culverts lowered. By lowering the riffle 0.3 ft, the velocity range for the target flows falls to 3-4.5 ft/s. However, this caused an increase in velocity through the culverts for some flows. For example, the velocity of the 143 cfs flow increased from 4 ft/s to 4.4 ft/s. (Figure 9)

By lowering the riffle crest 0.8 ft, the velocity range falls to 2.3- 2.8 ft/s, but velocity increased in the culverts for more flow rates. (Figure 10) During final design, additional iterations for the culvert configuration and riffle modification should be explored to optimize fish passage through both features.

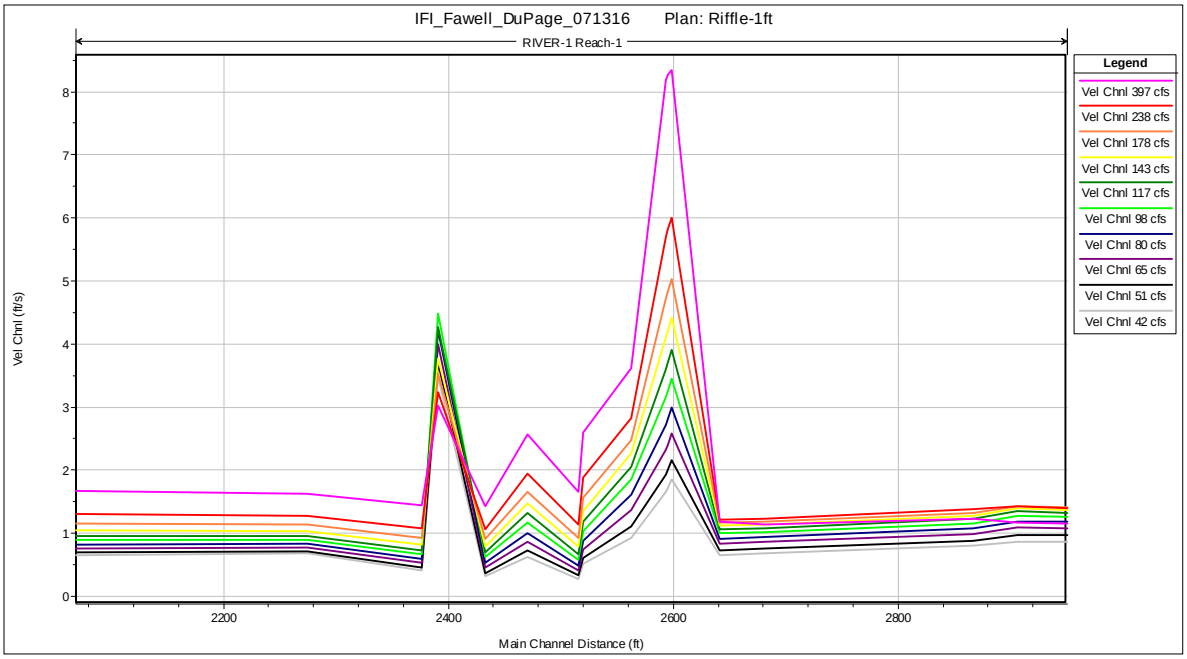


Figure 9. Flow velocities with two culverts lowered in Fawell Dam and the downstream riffle lowered by 0.3 ft (1 ft high riffle remaining).

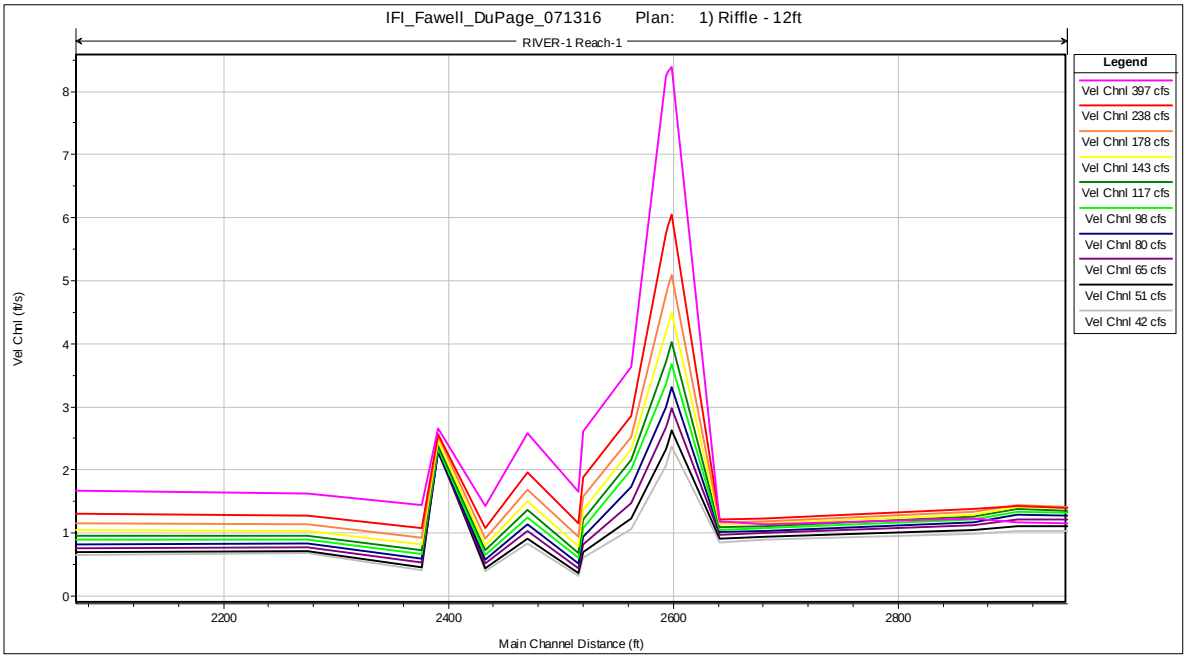


Figure 10. Flow velocities with two culverts lowered in Fawell Dam and the downstream riffle lowered by 0.8 ft (0.5 ft high).

BOUNDARY LAYER HYDRAULICS

As mentioned previously, many of the smaller target fish are expected to be weaker swimmers than northern pike based on the data available from laboratory swim tube experiments. Although such tests are not considered to be as accurate as tests in which individuals ascend actual channels against known hydraulic characteristics, for many species the laboratory swim tube tests must be at least considered. Consistent with reported laboratory results for the weakest swimmers on the target list, we will assume a target maximum velocity of 1 ft/s. Most of the weaker swimmers are small fish that typically swim against stronger currents by staying close to the river bottom where velocities are lower than the average velocity within the stream cross section.

Friction forms between a flowing fluid and an adjacent solid, creating a zone of restricted flow adjacent to the solid called the boundary layer. Velocities across the boundary layer vary from zero at the boundary to the "free stream" velocity at the outer edge of the boundary layer. In rivers, shallow depths and channel roughness usually result in the boundary layer extending to the surface, however flow velocity increases relatively quickly between the bed and the lower 20% of the flow, and then becomes more consistent through the upper portion of the water column. Velocity distributions tend to increase with height above the bed surface according to the following equation:

$U_y = b \ln(y/y_0)$

Where U_y is the mean velocity at a given height y above the bed surface, b is the velocity gradient which is a function of shear stress, and y_0 is the projected height above the bed where velocity is 0 ($y_0 \sim D_{sed}/30$). This equation is often referred to as the *law of the wall* for the general variation of velocity with height above a bed surface (von Karman, 1931).

To evaluate whether slower or smaller fish might be able to utilize channel edges (i.e., bed or banks) or obstructions to more easily move upstream, we analyzed law of the wall predictions of velocity versus height above the bed for a range of uniform sediment conditions (Figures 11 and 12). Shear stresses were tested between 2 lb/ft^2 and 0.3 lb/ft^2 to bracket existing conditions on the riffle and within the proposed culverts between the 20% and 95% exceedance flows (238 cfs and 42 cfs, respectively), which is likely the limit for passage based on the HECRAS modeling results. The law of the wall results indicate that boulders or similar roughness elements with minimum diameters of 24 cm to 36 cm (10 in to 14 in) will create a 3 cm boundary layer with flow velocities of less than 1 ft/s (30cms/s) where shear stresses range from 0.25 lb/sf to 2.0 lb/sq. As shown by the line representing a very smooth surface (D = 0.1 cm), it is not possible to achieve velocities less than 3 ft/s within this range of shear stress.

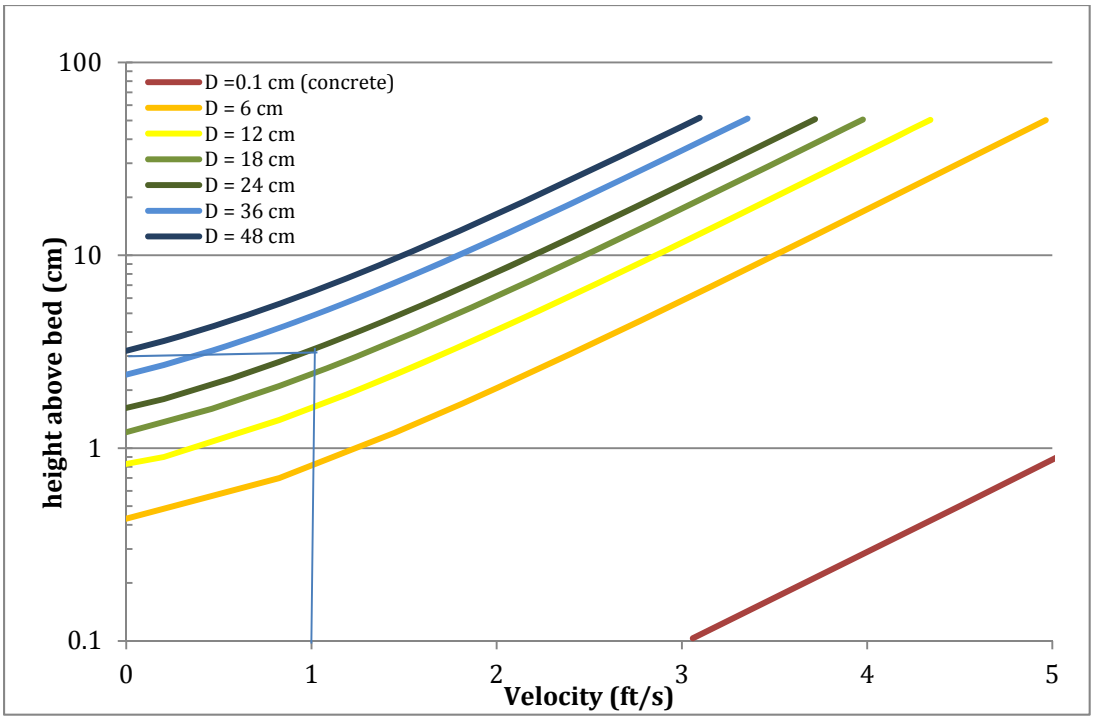


Figure 11. General variation of velocity with height above the bed over a range of bed sediment diameters. Calculations based on a shear stress of 0.25lbs/ft^2. For a velocity of 1 ft/x at a height of 3 cm from the bed, bed material with a diameter of approximately 24 cm would be required.

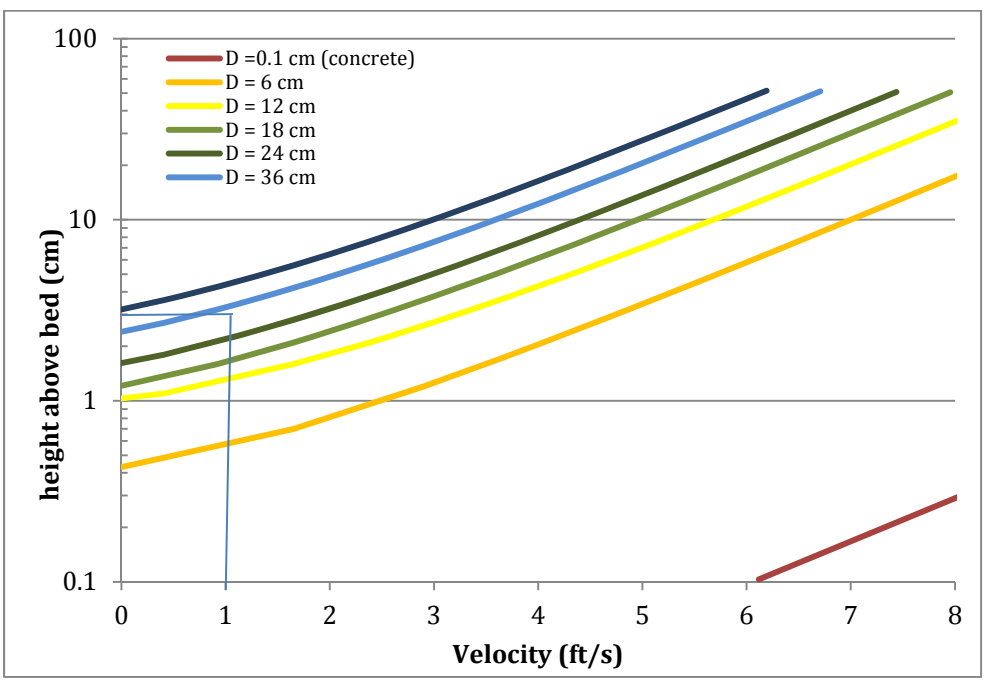


Figure 12. General variation of velocity with height above the bed over a range of bed sediment diameters. Calculations based on a shear stress of 2 lb/ft^2. For a velocity of 1 ft/x at a height of 3 cm from the bed, approximately bed material with a diameter of almost 36 cm would be required.

3 Upstream Geomorphic Adjustment

GEOMORPHOLOGIC PROCESS

In general, stream-channel processes can be characterized by the interaction between (1) supply and transport of sediment, (2) stream discharge (especially annual peak flows), (3) channel slope, and (4) channel cross section shape and sinuosity (Lane 1955). When the energy associated with water flow rate and channel slope are in balance with the sediment load and bed material size, the channel is considered stable and in equilibrium (Figure 13). However, significant changes to the system that alter one or more of these four channel attributes often force adjustments in the other attributes as the stream attempts to return to an equilibrium state. For instance, if the channel slope is increased significantly, the channel will work to reduce the slope via vertical erosion (incision) and horizontal migration (meandering - widening) to return to a stable condition (Figure 13).

Once destabilized by natural and/or human-induced disturbances, alluvial channels, like the West Branch DuPage River, generally adjust through a sequence of channel forms over time (Schumm et at., 1984; Simon and Hupp, 1986; Simon, 1989). These systematic adjustments are collectively described as "channel evolution" and permit interpretation of past and present channel processes, and general predictions of future channel form and activity. The channel and bank-slope evolution models generally have five stages based on shifts in dominant adjustment processes (Figure 14).

- Stage I represents the equilibrium channel as the initial, stable condition
- Stage II is the channel condition immediately after a disturbance, such as dredging or reduction of base level (e.g., lowering grade control/base level), resulting in an unstable condition. During this phase, the channel bed experiences accelerated degradation (i.e., bed erosion, incision, downcutting) associated with increased channel slopes and stream energy at the disturbance. The initial incision often results in a narrow, relatively deep channel set within the Stage I and II floodplain and previous channel surface (Figure 14). Streambed degradation usually occurs through the formation and upstream migration of *nickpoints or headcuts*, which are locally steep channel reaches (Figure 14).
- Stage III begins once bank heights increase to the point of instability and begin to fall into the channel. Generally the channel is widening during this stage, though it may also include ongoing incision. As the nickpoint in Stage II passes, it lowers the downstream channel gradient, but also results in high, over-steepened banks (Figure 14).
- In Stage IV, the lower channel gradients that result after nickpoints have passed through reduce the ability of a stream to transport upstream sediment, and therefore, material is deposited and the bed begins to rise at the downstream end of the impacted reach. Bank erosion also continues through Stage IV, as bars force flow against already over-steepened banks, and flood flows contained within the incised channel may still have additional energy.
- Stage V is the attainment of a new dynamic equilibrium with a wider channel, a properly sized channel and floodplain, and, although not shown, a more sinuous planform.

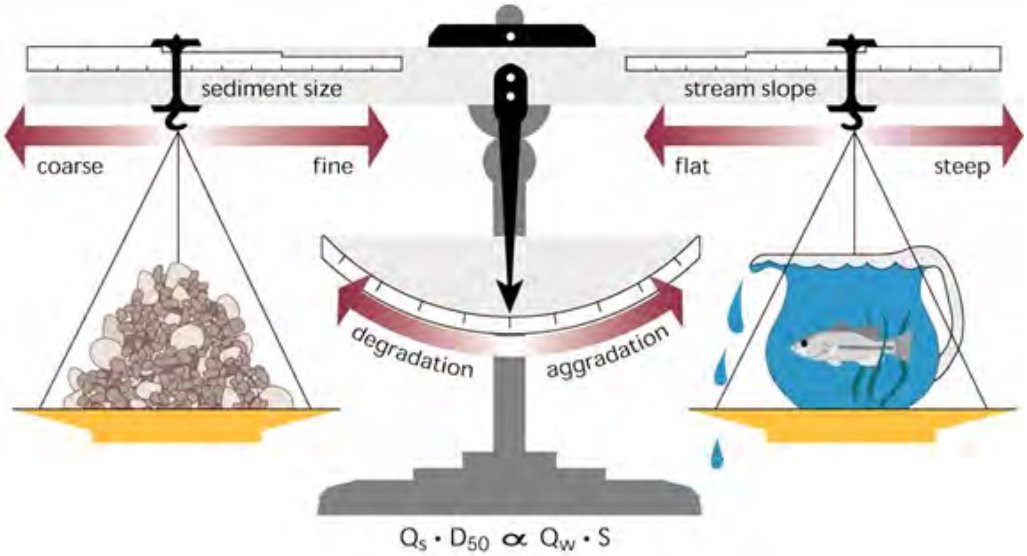


Figure 13. Lane's Balance (1955)– Channels in equilibrium balance their slope and flow capacity with their sediment load and sediment size.

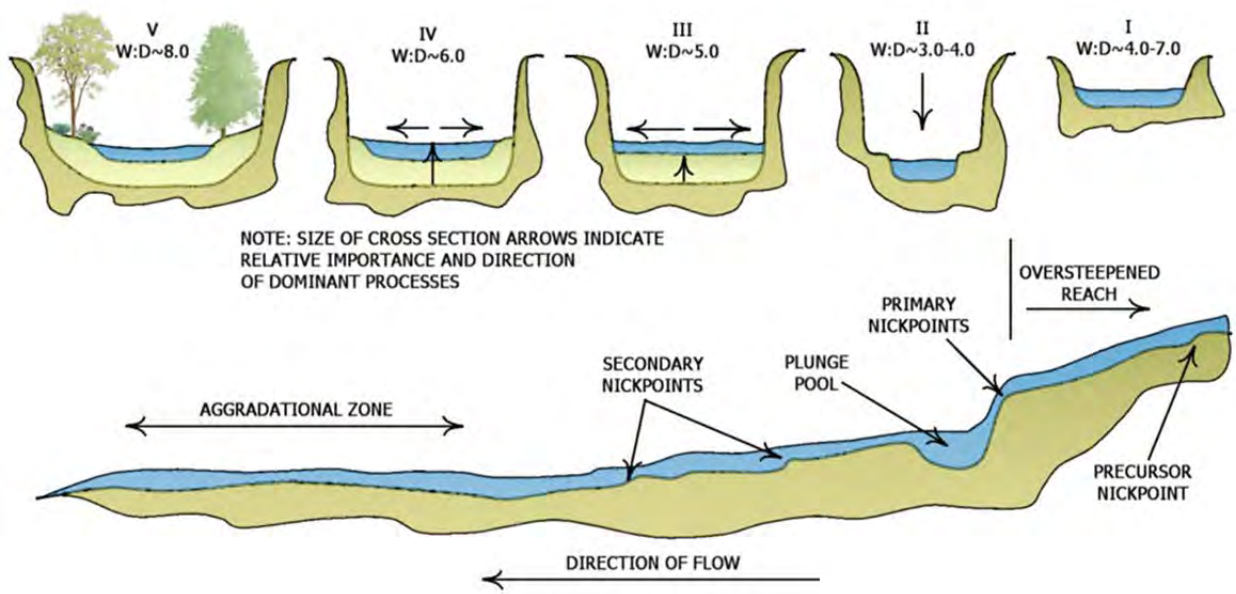


Figure 14. The channel evolution model. See text for description.

EXISTING CONDITIONS

On August 20, 2014 and September 4, 2014, IFI completed a survey between the West Ogden Ave Bridge and approximately 2,000 ft upstream of the West Drive Bridge. Data collection and findings from this investigation were described in IFI' s data collection memorandum (2014) and are summarized below.

The average bankfull channel width and depth from the surveyed cross sections in the impoundment were 157 ft and 4.5 ft, respectively. Although some unconsolidated silts and organics were present along the margins of the low flow channel, gravel, large cobbles, and some small boulders lined the channel bed throughout the impoundment. Fine sediment thickness ranged from 0 and 3.5 ft at the measured cross-sections, although they were usually relatively small layers (<1 ft). Additionally, the refusal elevations, or elevations of the rocky or compacted hard surface below the fine sediment, were relatively consistent across the entire river valley. The variation in elevation was within 1-2 ft. Sediments in the floodplains were mostly silts and sands.

The longitudinal profile shows a distinct wedge of backwater induced by Fawell Dam during base flow conditions (Figure 15), which propagated nearly 3,000 ft upstream to the first significant meander above the dam at the time of survey (~80% exceedance flow). The thalweg profile and the refusal elevations suggest minor accumulation of sediment behind the dam. The depth of refusal (DOR) profile suggests the channel formerly had a slope of approximately 0.0007 ft/ft. Also evident in the profile are the higher bank top elevations behind the dam indicating accumulation of floodplain sediments. The bank heights just upstream from the dam are nearly 3 ft higher than just downstream from the dam. A number of trees in the floodplain adjacent to the impoundment appeared to have buried root crowns, suggesting sedimentation in the floodplain over the last 20-40 years.

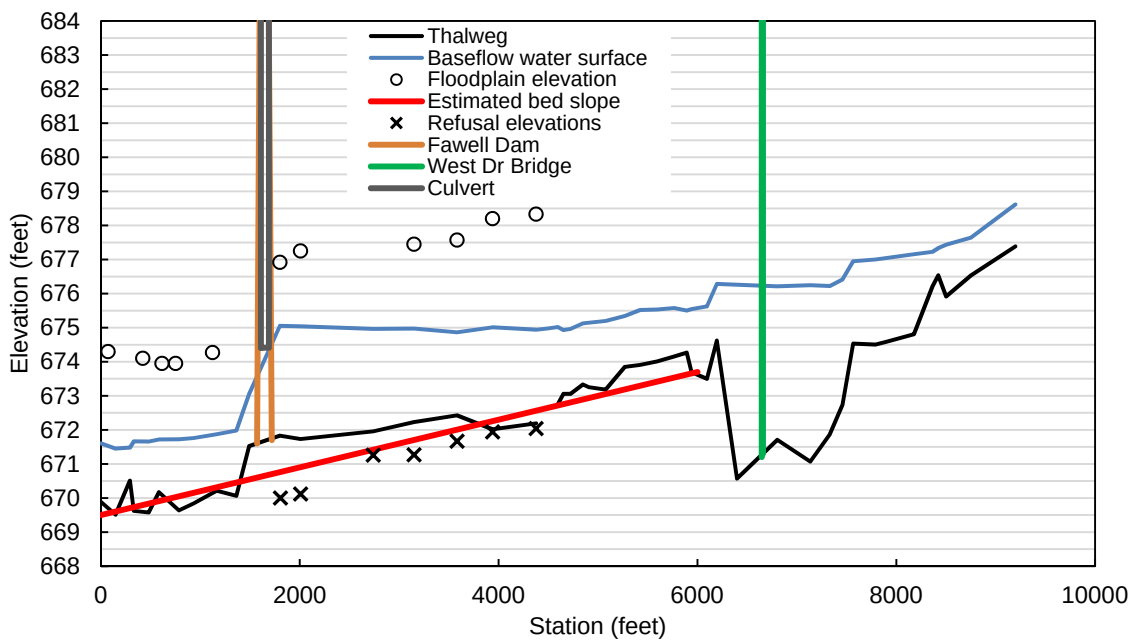


Figure 15. Longitudinal profile of the West Branch DuPage River reach surrounding the Fawell Dam. The water surface elevation (blue line) was surveyed during base flow conditions (flow exceeded 80% of the time) and shows that the dam creates about 3 ft of backwater. The channel bed (black line) and bank tops (open circles) indicate some sediment deposition upstream from the dam.

ANTICIPATED ADJUSTMENT PROCESS

Based on the channel evolution model (Figure 14) and the existing conditions, we can anticipate how the channel upstream of Fawell Dam will react and adjust to lowered culverts. First, the channel bed will be lowered mechanically when the culverts are lowered. This action will create an over-steepened bed just upstream (i.e., nickpoint), which will incise down to the resistant layer and begin migrating upstream (Stage II in the channel evolution model). The nickpoint will continue moving upstream along one or more headcuts, reducing the slope within the channel until it equilibrates with the sediment and flow. The final bed position will likely be similar to the DOR profile, with a slope near 0.0007 ft/ft. The incision width during this stage will likely be similar to the combined width of the lowered culverts, and the incision depth may be similar to the depths of refusal. Therefore, the channel will likely get 0 to 2 feet deeper in the impoundment. Generally, Stage II occurs relatively quickly; after a few storm flows pass through the system if the impounded material is relatively fine and non-cohesive, but because flow will continue to be restricted at the Fawell Dam location, it may take longer at this location.

In Stage III of the channel evolution model, the low flow channel along the incision will start to widen via meander migration and bar pressure related to upstream sediment evacuation during Stage II. In this stage, adjustment will proceed laterally along the coarser resistant layer, instead of vertically. Some of the finer material in the margins of the low flow channel will be removed,

The final width of the low flow channel will depend on upstream inputs, the cohesion of the channel material, vegetation, and other parameters. Currently, the gates are operated to pass a 690 cfs flow (at Warrenville Gage). The partial duration flood series results indicate that this discharge occurs once every 2.5 months. In some urban rivers, the 1.5 to 3 month recurrence interval flood coincides with bankfull discharge(Konrad et al., 2005; Annable et al., 2010). Consequently, if similar flows are allowed to pass through the modified culverts, it is possible that the river will fully adjust to a modified equilibrium condition based on these lower flood flows. However, the channel upstream of the impoundment appears to be adjusted to a flow closer to 1000 cfs. Because this higher flow, and the larger floods which are often associated with channel formation and maintenance (i.e., 1.5-5YR recurrence interval floods), will still be impounded by the dam, predicting channel size based on hydraulics or nearby references is difficult. Dam operations will likely inundate the upstream channel and floodplain for extended time periods, limiting vegetation cover, a key component of bank and floodplain stability, and inducing sedimentation within the reach. The low flow channel will likely experience variable amounts of sedimentation during larger flows, followed by flushing of fine sediment during lower flows. Eventually, the low flow channel will likely develop a stable or quasi-stable width, depth, and planform based on the sediment and flow conditions, but predicting the exact dimensions of the channel is not possible. Given the energy reduction imposed by the operation of the dam at higher flows, we do not anticipate that the channel will migrate outside of the existing impoundment into areas that are currently stabilized with vegetation, but lowering the culverts should create more stream-like conditions upstream of the dam for a longer period of time each year, relative to existing conditions. Expected short term and potential longer term evolution concepts are presented in Appendix A.

Summary

Lowering two of the Fawell Dam culverts will improve fish passage and restore some natural geomorphic form and function. Passage should be enhanced by roughening the culvert bottoms by securing boulders to the concrete. Lowering the culvert inverts will re-establish the pre-dam thalweg elevations upstream of the dam and will also minimize backwater during low flow conditions. Flow velocities through the impoundment will increase and the habitat will shift from a more lentic to a more lotic environment. This action will favor species native to the West Branch DuPage River.

If culverts are lowered for low flow fish passage, the upstream channel will likely adjust accordingly. Channel change will likely evolve via minor incision to the depth-of-refusal gravel layer, followed by lateral removal of finer material. Impoundment of larger flows limits the predictability of stable or quasi-stable channel dimensions. However, lowering the culverts will likely create more stream-like conditions upstream of the dam for longer periods of the year. Following passive establishment and natural stabilization of a new channel, habitat enhancements within the stream may be considered to further increase diversity and abundance of native fish in the reach.

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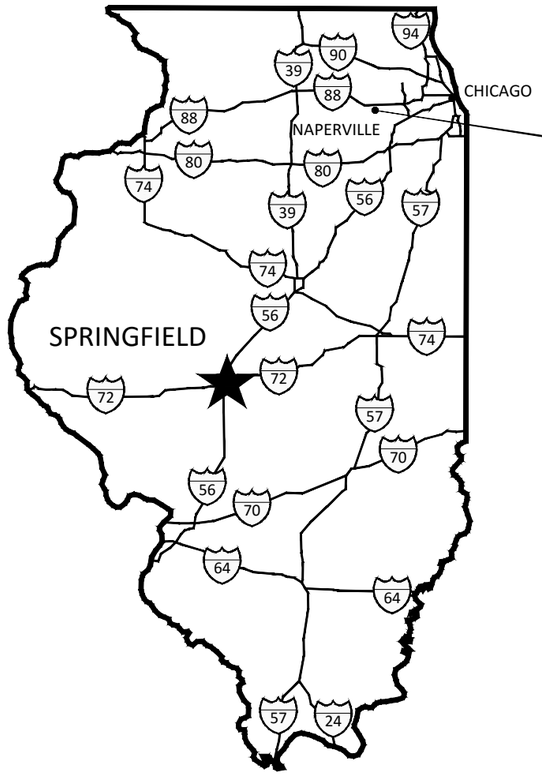
Appendix A – Channel Evolution Concept

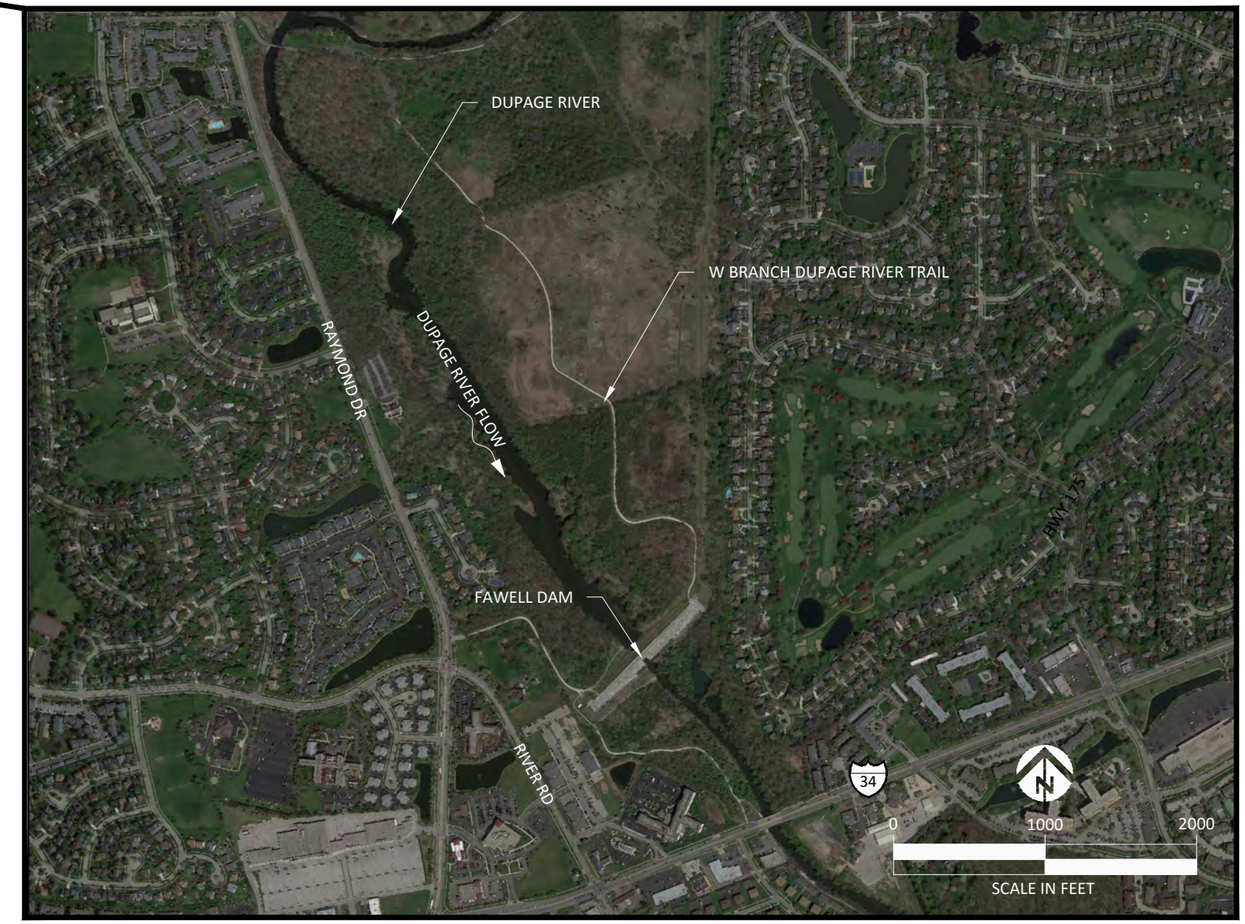
FAWELL DAM MODIFICATION, WEST BRANCH DUPAGE RIVER
DUPAGE COUNTY, ILLINOIS

Exhibit, July 12, 2016



STATE MAP - ILLINOIS
NOT TO SCALE

SHEET INDEX



LOCATION MAP
SCALE 1" = 1000'

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TITLE SHEET & SHEET INDEX
FAWELL DAM MODIFICATION, WEST BRANCH DUPAGE RIVER
DUPAGE COUNTY, ILLINOIS

PLAN LEGEND

EXISTING CHANNEL THALWEG

PROPERTY BOUNDARIES

1 PHOTOGRAPH LOCATION & ORIENTATION

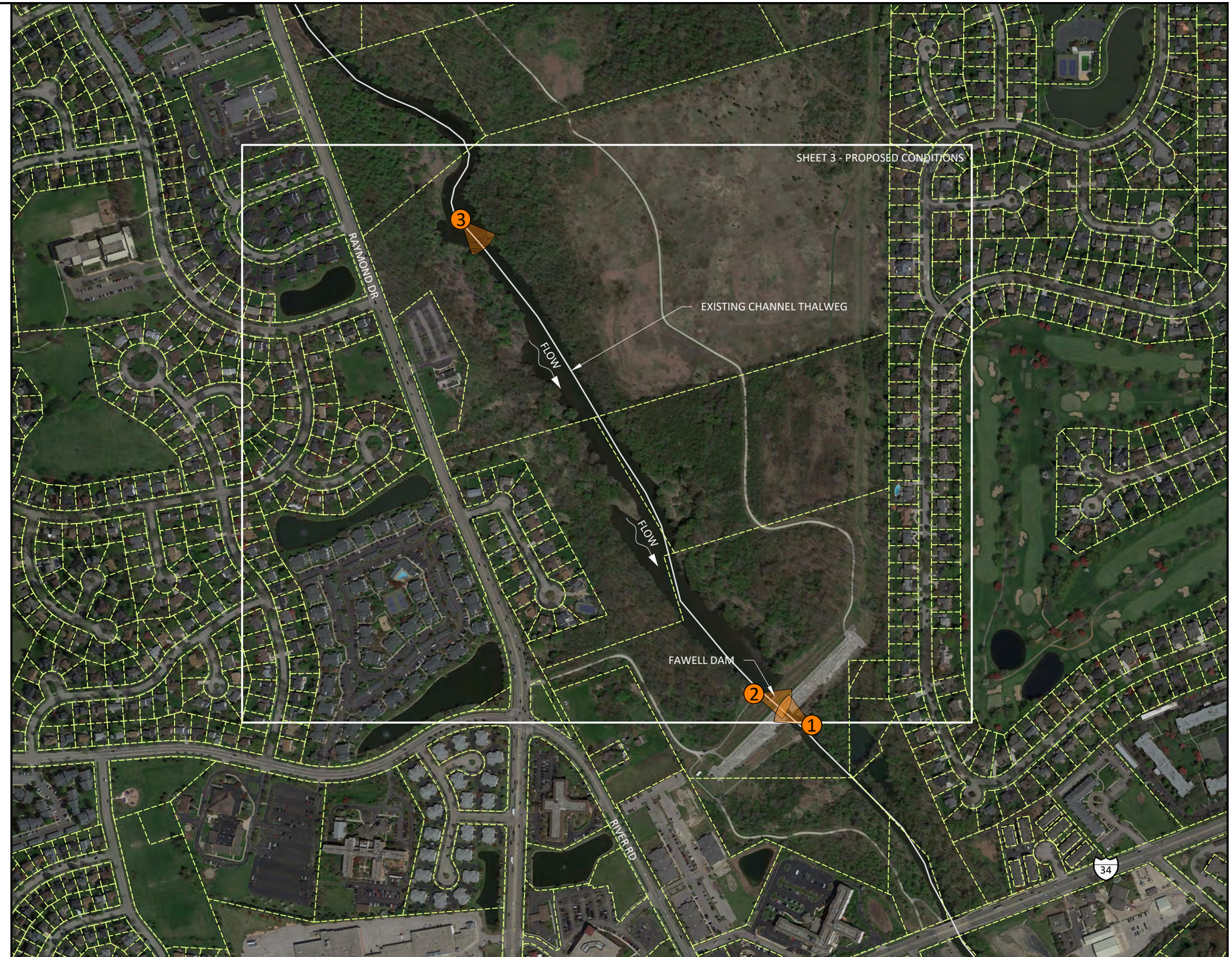
PHOTOGRAPH 1: LOOKING UPSTREAM AT FAWELL DAM

PHOTOGRAPH 2: LOOKING DOWNSTREAM AT FAWELL DAM

PHOTOGRAPH 3: LOOKING DOWNSTREAM

0 500 1000

SCALE IN FEET



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EXISTING CONDITIONS

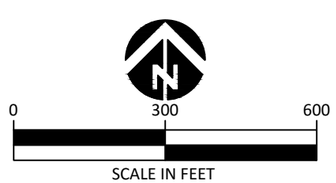
FAWELL DAM MODIFICATION, WEST BRANCH DUPAGE RIVER

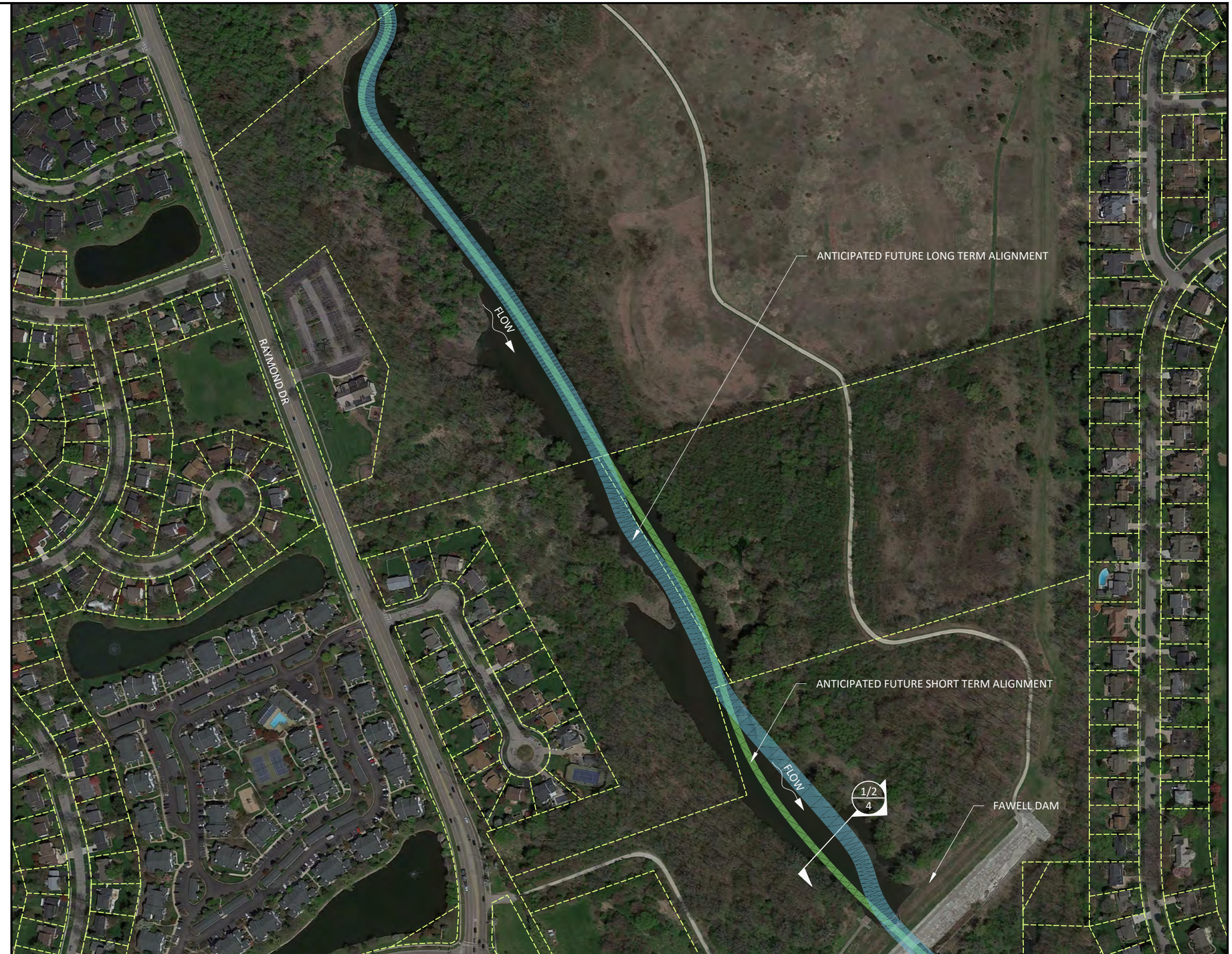
DUPAGE COUNTY, ILLINOIS

PLAN LEGEND

- ANTICIPATED FUTURE SHORT TERM ALIGNMENT
- ANTICIPATED FUTURE LONG TERM ALIGNMENT
- PROPERTY BOUNDARIES

SHEET 2 - EXISTING CONDITIONS





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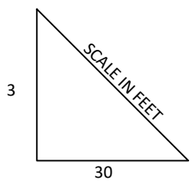
PROPOSED CONDITIONS

FAWELL DAM MODIFICATION, WEST BRANCH DUPAGE RIVER

DUPAGE COUNTY, ILLINOIS

LEGEND

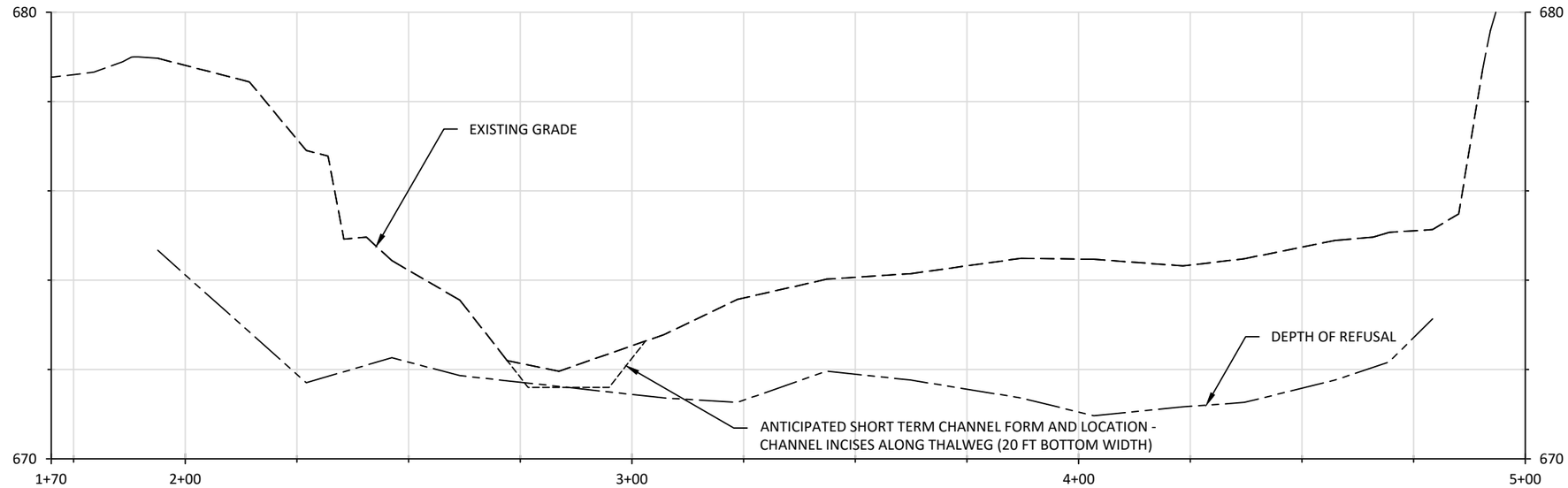
- EXISTING GRADE
- ANTICIPATED LONG TERM CHANNEL FORM
- DEPTH OF REFUSAL
- ANTICIPATED SHORT TERM CHANNEL FORM



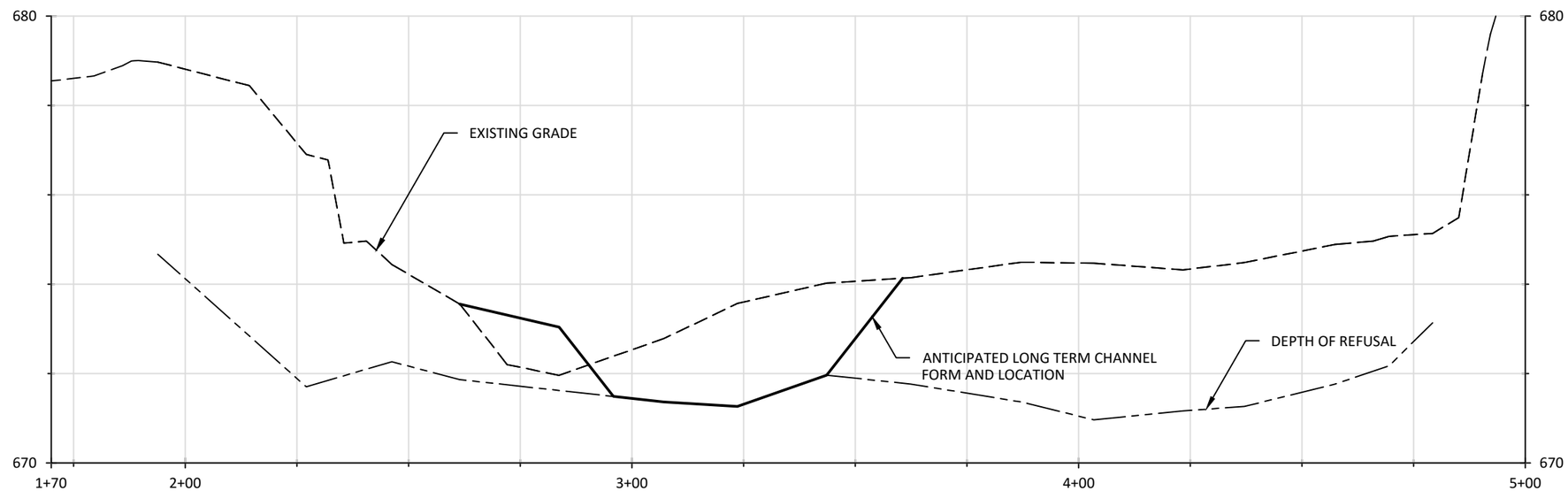
NOTE:

ANTICIPATED CHANNEL EVOLUTION FOR THE FAWELL DAM PROJECT REACH IS BASED ON THE CHANNEL EVOLUTION MODEL (CEM) PROPOSED BY SIMON AND RINALDI (2006). ACCORDING TO THE CEM, THE CHANNEL WILL LIKELY INCISE VIA UPSTREAM KNICKPOINT MIGRATION UNTIL IT CUTS DOWN TO A MORE RESISTANT BED LAYER (E.G., THE DOR LAYER). THE CHANNEL WILL THEN WIDEN AND ESTABLISH A NEW STABLE CONFIGURATION.

TIMING AND FINAL CHANNEL POSITION AND CROSS-SECTION DIMENSIONS ARE ONLY ESTIMATES BASED ON DOR POSITION AND COMBINED CULVERT WIDTH.



1/5 CROSS SECTION
ANTICIPATED SHORT TERM CHANNEL FORM AND LOCATION



2/5 CROSS SECTION
ANTICIPATED LONG TERM CHANNEL FORM AND LOCATION

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PRELIMINARY CHANNEL SIZING

FAWELL DAM MODIFICATION, WEST BRANCH DUPAGE RIVER

DUPAGE COUNTY, ILLINOIS