

Hydraulic & Hydrologic Study Parameters for a Future Upper St. Croix Watershed Study

Introduction

Upper St. Croix Lake is located roughly 10 miles upstream of the St. Croix Flowage and on the east shore of the town of Solon Springs, WI in Douglas County. Over the years, locals have expressed a concern that the high water in the Upper St. Croix Lake may be caused by backwater effects created by the operation of Gordon Dam, which is located on the downstream end of the St. Croix Flowage, also in Douglas County, WI. In the past 35 years, there have been a number of studies that investigated the possible reasons for high water levels on the Upper St. Croix Lake; however, none of them conclude that the high water levels are a result of the dam's operations.

In an effort to guide future studies in the Upper St. Croix watershed, this document will address how a future hydraulic & hydrologic (H&H) study might be conducted to improve on existing studies and information.

Data

There is existing historic data available from the USGS on discharge measurements obtained at various locations in the area. There are also existing stage measurements in the area, however; the USGS did not survey the gages datum at the time so actual water surface elevation data is not available. Past studies refer to data collected by the Wisconsin Department of Natural Resources, however, that data is no longer available.

Hydraulic Modeling

Hydraulic modeling is recommended for the study to determine water surface elevations along the St. Croix River through the St. Croix Flowage and Upper St. Croix Lake for different flow conditions. There are various tributaries in the immediate area, the largest of which is the Eau Claire River. The Eau Claire River enters the St. Croix River at Gordon, WI and immediately upstream of old UW Hwy 53. From aerial photos it appears there may be a depositional area at the mouth of the Eau Claire River.

Analysis Methods

A HEC-2 model built in the 1970s exists from the reach of the St. Croix River from approximately the railroad bridge, immediately upstream of the Eau Claire River, at Gordon, WI to the upstream end of the Upper St. Croix Lake near Solon Springs, WI. It is recommended that a new model, preferably HEC-RAS, be created using new geometry and calibrated to new hydraulic data. The Mannings n values used in the HEC-2 model could be used as a starting point for the new model.

Data Required for Model

Updated survey data and accurate hydraulic data are critical to the effectiveness of the modeling and determining what is causing high water levels on Upper St. Croix Lake.

Topographical Information

Regardless of which alternative the modeler chooses, a few key pieces of information will most-likely be needed. For the most accurate results, it would be best to use some form of high-resolution digital terrain model (DTM), such as LiDAR, to either cut new cross sections or extend existing cross sections across the floodplain. Since there appears to be some new bridge construction since the last study, bridge information (i.e.: low chord elevation, number of piers, pier width, etc.) would need to be gathered and incorporated into the model.

In addition to the topographical floodplain information obtained for the cross sections through a DTM, bathymetric data for the cross sections will also be needed. This can be obtained by pole soundings from a survey crew or hydrographic surveys if water levels are high.

Discharge Measurements

There are limited historic discharge measurement data available from the USGS. The discharges are useful in providing a picture of the flows coming from different sources. Discharge measurements should also be gathered at a number of locations to aid in model calibration. Below is a list of recommended locations for discharge measurements, which can also be seen in Appendix A.

- Foot bridge downstream of Upper St. Croix Lake, near the intersection of Cut-A-Way Dam Road and Hungry Bear Trail (~46° 18' 23" N, 91° 47' 17" W).
- Old Hwy 53 Bridge (Gate Road Bridge) at Gordon, WI (~46° 15' 7" N, 91° 48' 1" W).
- At Gordon Dam (~46° 15' 15" N, 91° 55' 39" W).

Water Surface Elevations (WSE)

Water surface elevations (WSE's) will need to be gathered at a number of different locations throughout the Upper St. Croix watershed. Below is a list of recommended WSE locations, which can also be seen in Appendix A.

- South County Road A bridge, just upstream of Upper St. Croix Lake (~46° 23' 02" N, 91° 46' 38" W).
- Foot bridge downstream of Upper St. Croix Lake, near the intersection of Cut-A-Way Dam Rd. and Hungry Bear Trail (~46° 18' 23" N, 91° 47' 17" W).
- Old Hwy 53 Bridge (Gate Road Bridge) at Gordon, WI (~46° 15' 7" N, 91° 48' 1" W).
- At Gordon Dam (~46° 15' 15" N, 91° 55' 39" W).
- South Mail Road bridge, just downstream of Gordon Dam (~46° 15' 17" N, 91° 57' 49" W).

All proposed WSE locations seen on the 'Proposed Water Surface Elevation Gaging Locations for the St. Croix Headwaters' map in Appendix A are placed at bridges, so WSE's can easily be recorded on the upstream and downstream sides of each bridge, respectively. In order to have

confidence with the model outputs, WSE's should be recorded at all locations on the same date for at least two events (one high flow event, one low flow event).

Cost Estimation

A rough cost estimate is provided below for all the items that would be needed for a hydraulic modeling of the Upper St. Croix Lake. The provided estimate assumes that a DTM with sufficient resolution already exists. If that is not the case, the expense incurred by obtaining that information should be added to the total price found below.

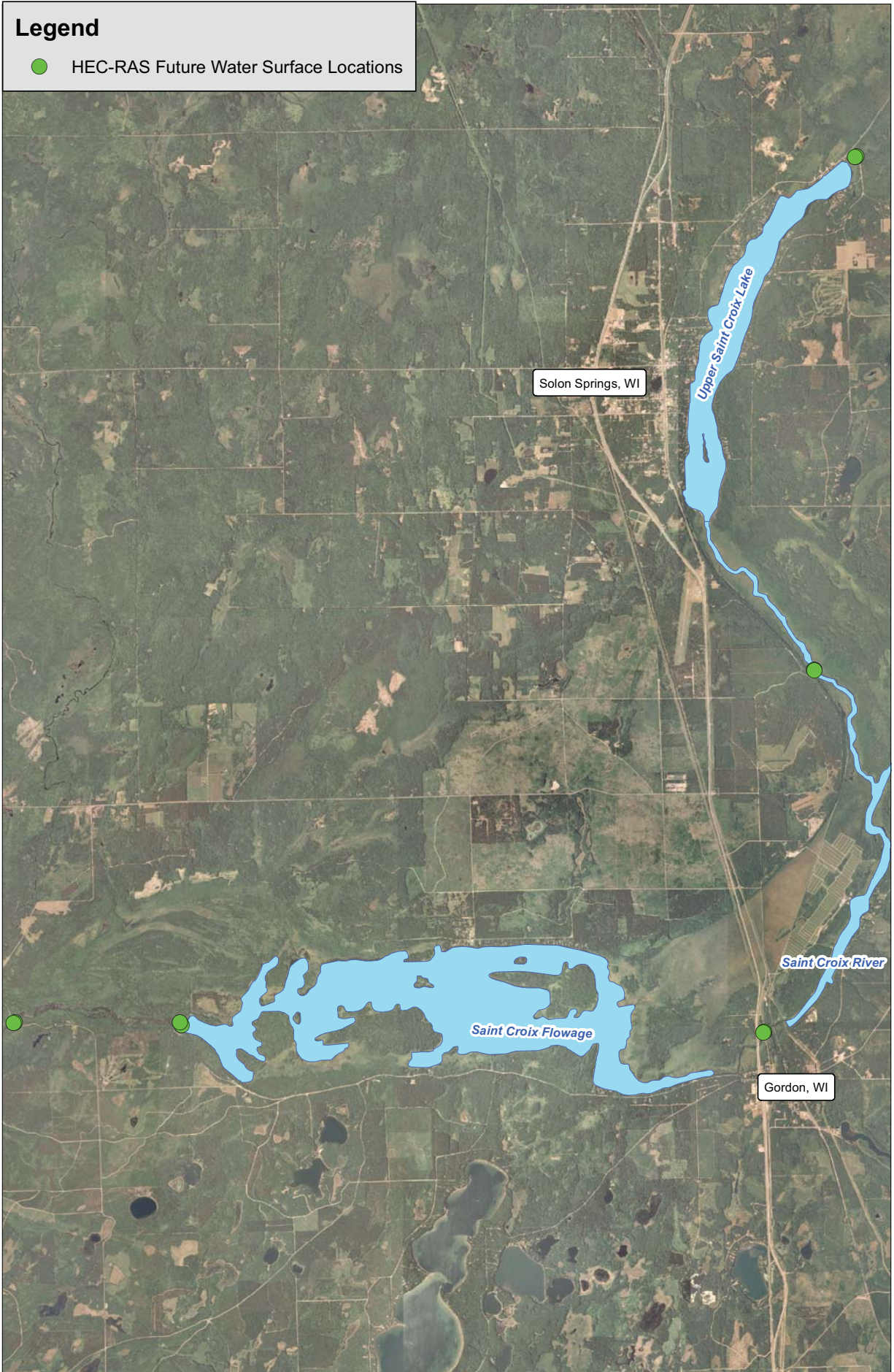
The Wisconsin USGS office developed some rough cost estimates for different stream discharge and gage height combinations. Option 1 is shown in the cost estimate because it was the least expensive option. The remaining options are detailed in Appendix B.

| Task | Number of People | Hours Required | Hourly Rate | Item Total |
|--|-------------------------|-----------------------|--------------------|-------------------|
| Cross Section Survey | 3 | 36 | \$100.00 | \$12,000.00 |
| Discharge & Stage Measurements by USGS (Option 1) | | | | \$10,000.00 |
| Gathering Available Information and Data for Model | 1 | 8 | \$120.00 | \$960.00 |
| Hydrology Update / Verification | 1 | 12 | \$110.00 | \$1,320.00 |
| HEC-RAS Modeling | 1 | 40 | \$120.00 | \$4,800.00 |
| Project Analysis and Report | 1 | 40 | \$120.00 | \$4,800.00 |
| | | | | \$33,880.00 |

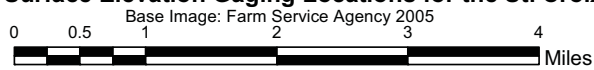
Appendix A

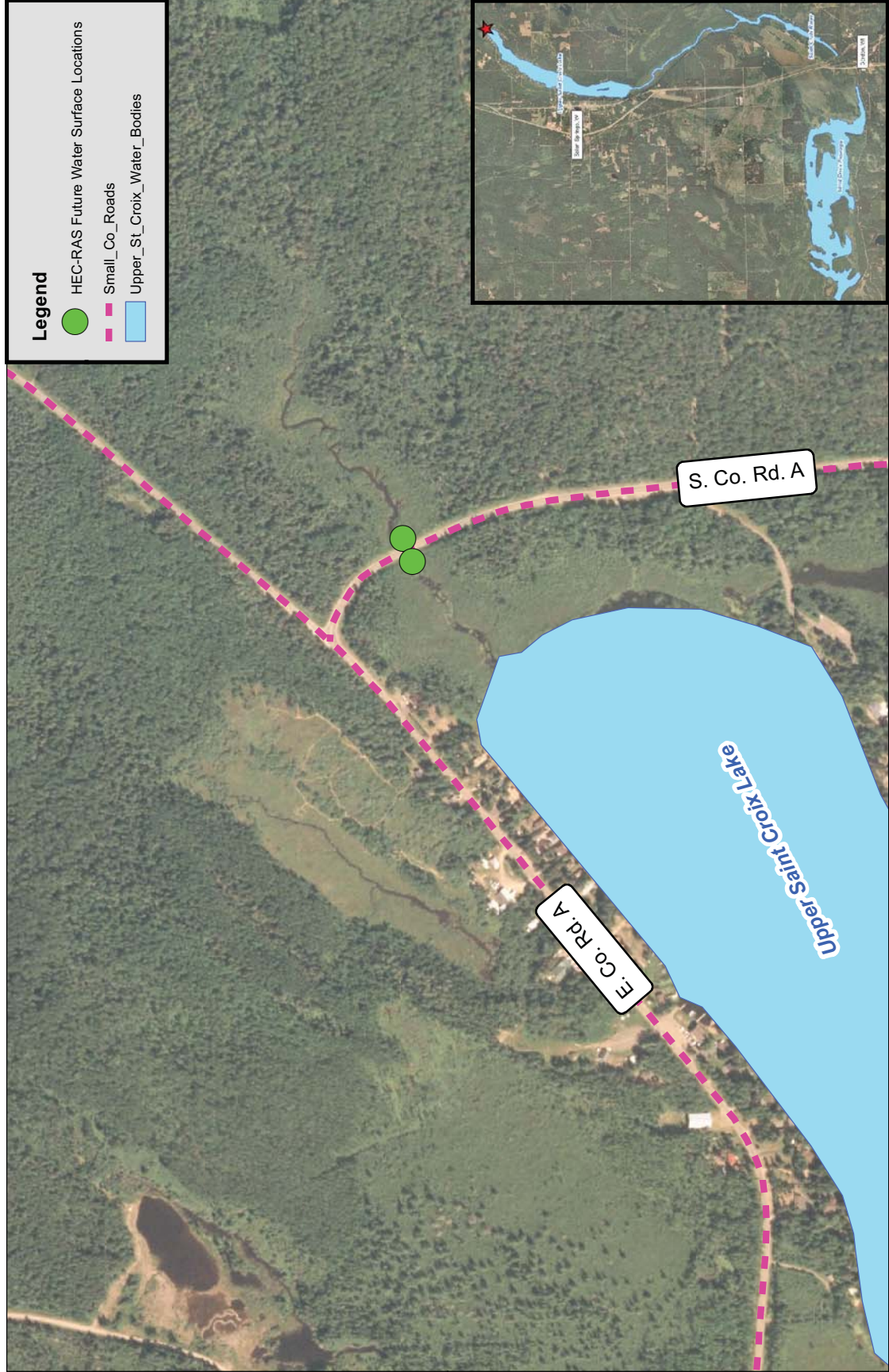
Legend

- HEC-RAS Future Water Surface Locations



Proposed Water Surface Elevation Gaging Locations for the St. Croix Headwaters



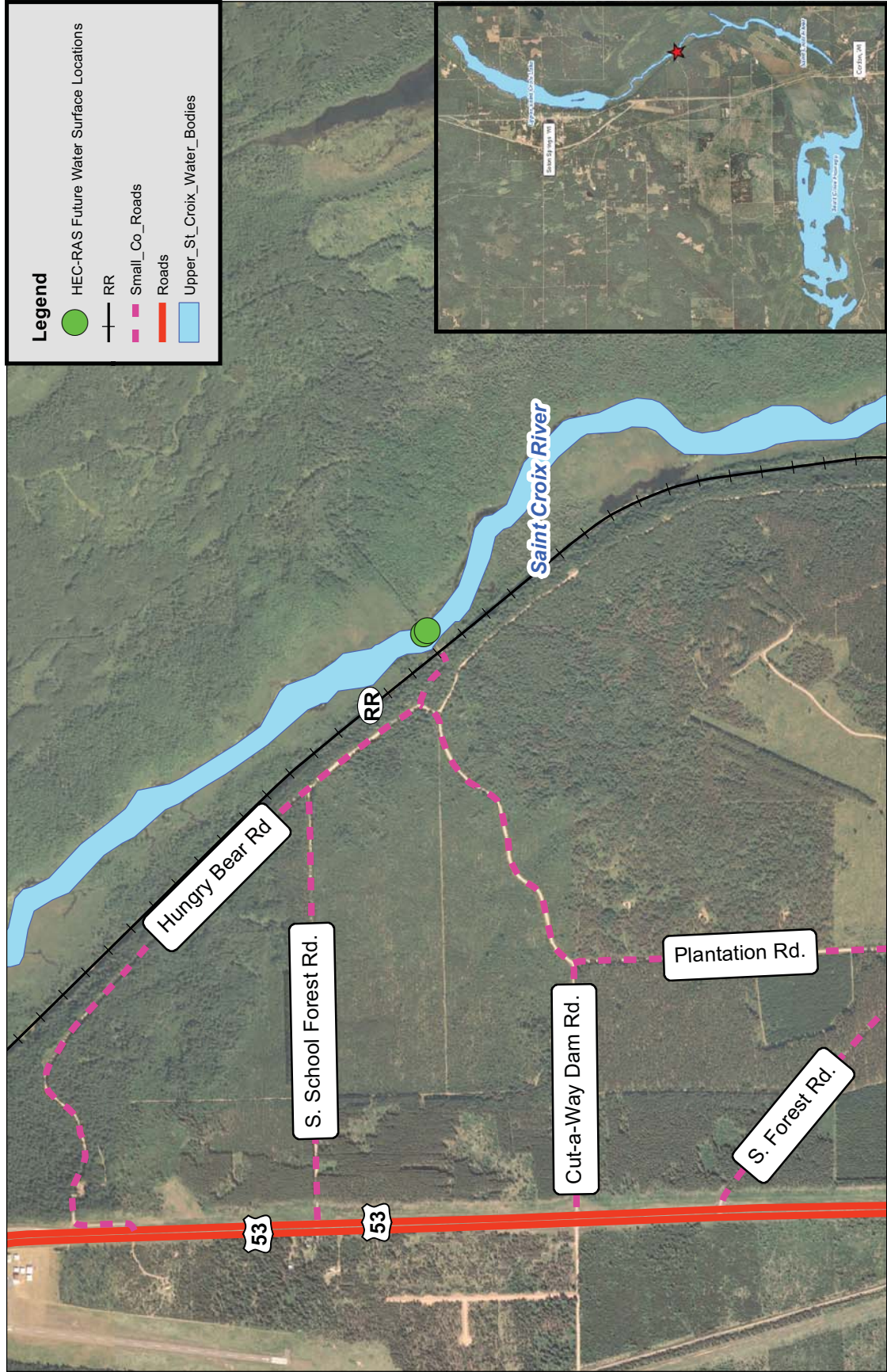


Legend

- HEC-RAS Future Water Surface Locations
- Small_Co_Roads
- Upper_St_Croix_Water_Bodies

Proposed Water Surface Elevation Gaging Locations Upstream of Upper St. Croix Lake



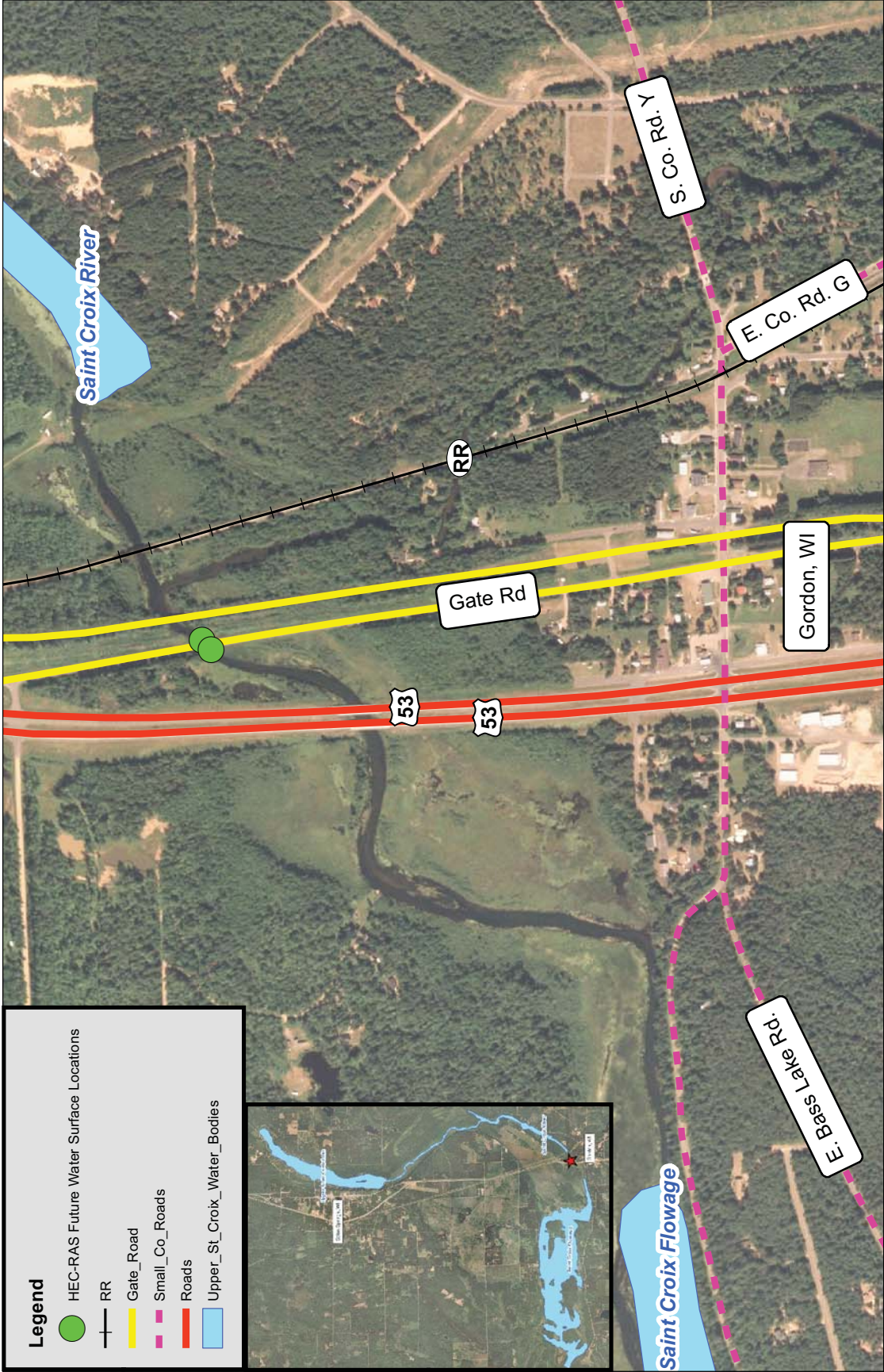


- Legend**
- HEC-RAS Future Water Surface Locations
 - RR
 - - - Small_Co_Roads
 - Roads
 - Upper_St_Croix_Water_Bodies

Proposed Water Surface Elevation Gaging Locations Downstream of Upper St. Croix Lake



X:\PROJECTS\SA_St_Croix_Headwaters_144135\Feasibility Work\Gordon Dam H&H Evaluation (5/25/12)



Legend

- HEC-RAS Future Water Surface Locations
- RR
- Gate_Road
- Small_Co_Roads
- Roads
- Upper_St_Croix_Water_Bodies

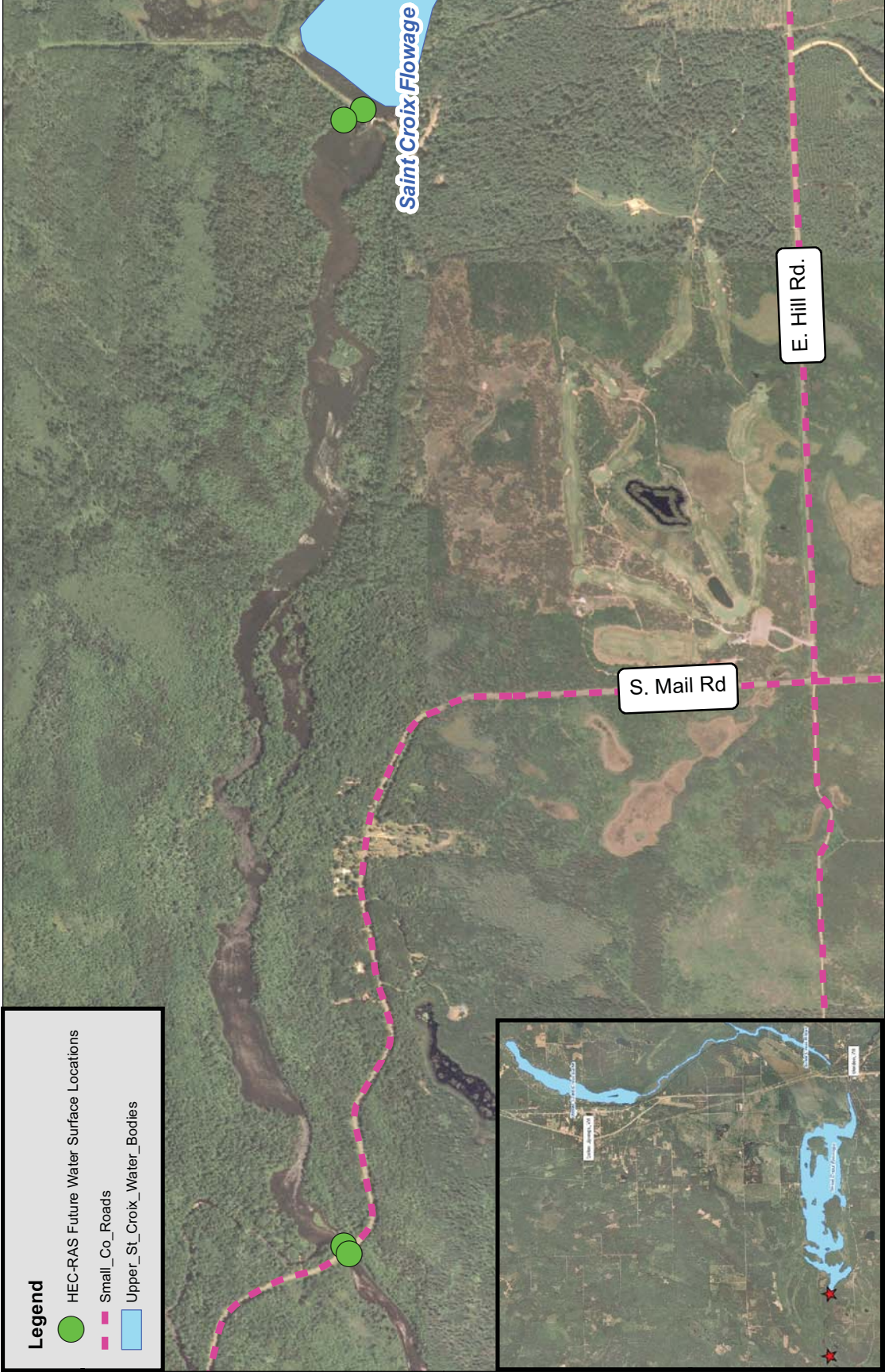


Proposed Water Surface Elevation Gaging Locations at Gate Road in Gordon, WI

St. Paul District
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Legend

- HEC-RAS Future Water Surface Locations
- - - Small_Co_Roads
- Upper_St_Croix_Water_Bodies



Proposed Water Surface Elevation Gaging Locations Downstream of Gordon Dam




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Appendix B

Upper St. Croix Monitoring 'back of the envelope' Cost Estimates

These are cost estimates for a range of data collection efforts. None of the options include data analysis (ie hydraulic modeling) or report writing. They include the data collection, compilation and QA. All daily discharge and stage data will be published in the Wisconsin Annual Water Data Report. Any continuous data will be made available on the USGS near real-time web page. Intermittent data (manually collected water surface data) will be QA'd and stored in the USGS database for future analysis.

Option 1. No continuous monitoring equipment. Make 5 data collection trips to the study area collect discharge measurements and water surface data.

-Install Reference Marks/Reference Points at 8 locations

-Run 2 level loops to the RMs/RPs. The first to establish elevations at the beginning of study. The second to verify elevations at the end of the study.

-Collect discharge measurements at 2 locations and get water surface elevations at 6 additional locations at 5 different times.

Option 2. Continuous monitoring equipment with telemetry at all 8 locations.

-Purchase and install continuous stage monitoring & telemetry equipment at 8 locations (including Reference Marks/Reference Points)

-Run 2 level loops to the RMs/RPs. The first to establish elevations at the beginning of study. The second to verify elevations at the end of the study.

-Collect discharge measurements and all equipment maintenance.

-Publish mean daily flow or stage for all locations for 1 year. Sub-daily data will be collected, QA'd and made available for analysis.

Option 3. Continuous monitoring equipment with telemetry at 2 locations and collect water surface data manually at the other 6 locations whenever the continuous sites are visited.

-Purchase and install continuous stage monitoring & telemetry equipment at 2 locations and Reference Marks/Reference Points at all 8 locations.

-Run 2 level loops to the RMs/RPs. The first to establish elevations at the beginning of study. The second to verify elevations at the end of the study.

-Collect discharge measurements and all equipment maintenance.

-Publish mean daily flow for the 2 continuous locations for 1 year. Sub-daily data will be collected, QA'd and made available for analysis. Intermittent water surface data will be available for analysis.

| Cost Summary | Cooperator | USGS | Total |
|---------------------|-------------------|-------------|--------------|
| Option 1 | 9500 | 3500 | 13,000 |
| Option 2 | 150,000 | 50,000 | 200,000 |
| Option 3 | 57,500 | 20,000 | 77,500 |

*USGS share is dependent on availability of funds