# HYDROLOGIC AND HYDRAULIC BASIS OF DESIGN REPORT

## Skagit Environmental Bank

Prepared for

Clear Valley Environmental Farm, LLC

June 2006

HERRERA
ENVIRONMENTAL
CONSULTANTS

**Note:**
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# HYDROLOGIC AND HYDRAULIC BASIS OF DESIGN REPORT

# Skagit Environmental Bank

Prepared for

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June 27, 2006

# Contents

# Tables



# Figures

# Introduction

Wetlands provide biodiversity, water quality improvement, flood abatement, and carbon sequestration. Unfortunately, over half of the wetlands in the United States have been destroyed since development began in the late eighteenth century (Zedler and Kercher 2005). This wetland loss has resulted in diminished water quality and floods that are more pronounced, decreasing the agricultural productivity of the adjacent landscape and the ability of local ecosystems to recover from natural disasters (Costanza et al. 1997). To compensate for the loss of wetlands, the Skagit Environmental Bank has endeavored to restore the wetland and floodplain functions that were typical before the wetland disturbance, to produce a restored system that is dynamic and self-sustaining, and to create a long-term management plan to address unforeseen changes in climate and hydrology.

The Skagit Environmental Bank plans to restore reaches of Nookachamps Creek, East Fork Nookachamps Creek, Mud Lake Creek, and associated floodplain wetlands, which together constitute the Bank Site. The plan for the proposed Bank Site is to reestablish or rehabilitate 13,000 feet (2.5 miles) of existing riverine channel habitat, restore 9,720 feet (1.8 miles) of new high-flow channel, and restore (reestablish or rehabilitate) 311 acres of palustrine emergent, scrub-shrub, and forested wetlands. The total area of the Bank Site is 311 acres. The total area of the 150-foot-wide buffers is 44 acres. The total area of the Bank Site including the buffers is 355 acres.

The Skagit Environmental Bank hired Herrera Environmental Consultants (Herrera) to assess the potential impacts of the measures proposed for restoring the wetland conditions. Herrera has used a suite of environmental models to predict the effects of the proposed measures on the Bank Site and on adjacent properties. In particular, Herrera has examined the influence of proposed engineered logjams (ELJs) used as grade control structures on the stage of flood waters and on the ground water elevation during the growing season.

# Hydrologic and Hydraulic Modeling

## Flood Hydrology

The influences of flood hydrology on the Bank Site could include both the flows within Nookachamps Creek and East Fork Nookachamps Creek and a range of possible backwater scenarios from the Skagit River. The Western Washington Hydrological Model (Version 2.5) was used to estimate flood flows for the 2-year, 25-year, and 100-year recurrence interval in Nookachamps Creek and East Fork Nookachamps Creek (Table 1). The land-use and reclassification-use maps used in the hydrologic analysis are provided in Appendix A.

**Table 1. Flood flows for various recurrence intervals in Nookachamps Creek and East Fork Nookachamps Creek based on the Western Washington Hydrological Model.**

| Flow | Upper Nookachamps Creek Flows (cfs) | East Fork Nookachamps Creek Flows (cfs) | Lower Nookachamps Creek Flows (cfs) |
|---|---|---|---|
| 2-year | 450 | 540 | 990 |
| 25-year | 1,400 | 1,705 | 3,105 |
| 100-year | 2,180 | 2,660 | 4,840 |

cfs = cubic feet per second.

## Hydraulic Model

The HEC-RAS model (Version 3.1.3) was used to provide water surface elevations of Nookachamps Creek on the Bank Site under various conditions. The geometric boundary conditions are based on a cross-sectional survey at 26 locations (Sheet R-11 in Appendix B). Three channel-spanning obstructions (ELJs), each placed 3 feet higher than the existing channel bed, were installed along the existing channel geometry of the main stem of Nookachamps Creek to represent the proposed channel geometry. The channel-spanning obstructions were modeled as raised cross-sections for a 10-foot-long channel. These short reaches were assigned a high roughness value (0.08) in order to calculate a conservative estimate of the backwater effects of the structures.

Several assumptions regarding the boundary conditions were evaluated to model the effects of the Skagit River on stage and discharge within the study reach. For this study, three scenarios were assumed: *no effect*, *moderate effect*, and *high effect*. The 100-year Skagit River flood elevation was assumed for the *high effect* scenario. The Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM) for the Skagit River was used to determine the 100-year flood elevation. The Skagit River 100-year flood elevation at the Bank Site is approximately 47.7 feet above the North American Vertical Datum of 1988 (NAVD 88). Hence, the site can be under as much as 15 to 20 feet of water due to backwater influence from the Skagit River. The Phase 1 flood elevation at U.S. Geological Survey (USGS) gauge 12205500 on the Skagit River near Mount Vernon was used as a *moderate effect* to approximate a first-stage flood hazard where the Skagit River is flooding and producing a backwater in Nookachamps Creek.

### Model Calibration and Procedure

The HEC-RAS model was calibrated by adjusting the Manning's roughness coefficients ($n_i$) so that the computed water surface elevations replicated those measured in the field. The field measurements on April 19, 2006, were ideal for calibration since they represented close to bankfull conditions on the main stem, upstream of the confluence with East Fork Nookachamps Creek.

The effective roughness was initially estimated using Cowan's method (Cowan 1956), then fine-tuned within the range of the recommended values in Cowan's method to calibrate the model. Cowan's method includes a basic roughness coefficient ($n_1$) to represent bedforms, such as sands or gravels, and it includes additional roughness components for channel irregularities ($n_2$), cross-section changes ($n_3$), obstructions ($n_4$), vegetation ($n_5$), and meandering ($n_6$). Of particular importance is the upper portion of the main stem where the channel undergoes significant changes in cross-sectional area (constrictions) and obstructions, increasing the effective channel roughness. In general, a base value ($n_1$) was set to 0.02, and the total effective roughness was increased using $n_2$, $n_3$, $n_4$, and to a lesser extent $n_6$. The vegetation value ($n_5$) was adjusted along the banks and for a portion of the stream sides where overhanging vegetation plays a significant role in channel roughness.

Several model scenarios were run using the HEC-RAS model to represent the varying hydrologic characteristics and interactions of Nookachamps Creek with the backwater effects from the Skagit River (Table 2).

Scenarios 1 and 2 provide information on the influence of the ELJs for evaluation of anticipated water levels in the stream during the growing season (February through June) and their possible effects on surrounding ground water levels.

Scenarios 3 through 8 provide a comparison of water surface elevations under existing conditions and proposed conditions (channel spanning obstruction) when there are no backwater effects from the Skagit River. Scenarios 9 through 14 provide a comparison of water surface elevations when there is a moderate backwater effect from the Skagit River, and Scenarios 15 through 20 provide a comparison of water surface elevations when there is a high backwater effect from the Skagit River.

## Low-Flow Modeling

The hydraulic model results for the growing season scenarios were obtained by iteratively matching the stage output from the HEC-RAS model to the average observed stage at stream gauge 4 (at cross-section E7 [Sheet R-11 in Appendix B]) during the growing season (February through June). The results of this iteration were that 46 cubic feet per second (cfs) was conveyed by East Fork Nookachamps Creek during this time period, while 35 and 81 cfs flowed through the main stem above and below the confluence, respectively. A sensitivity analysis (±20 percent) of the growing-season average was also run to identify the impacts of variability in streamflow and ground water elevation from year to year.

**Table 2. Scenarios modeled in HEC-RAS.**

| Scenario | Channel Geometry | Skagit Backwater | Nookachamps Flow |
|---|---|---|---|
| 1 | Existing | None | Growing season average |
| 2 | Proposed | None | Growing season average |
| 3 | Existing | None | 2-year |
| 4 | Existing | None | 25-year |
| 5 | Existing | None | 100-year |
| 6 | Proposed | None | 2-year |
| 7 | Proposed | None | 25-year |
| 8 | Proposed | None | 100-year |
| 9 | Existing | Moderate | 2-year |
| 10 | Existing | Moderate | 25-year |
| 11 | Existing | Moderate | 100-year |
| 12 | Proposed | Moderate | 2-year |
| 13 | Proposed | Moderate | 25-year |
| 14 | Proposed | Moderate | 100-year |
| 15 | Existing | High | 2-year |
| 16 | Existing | High | 25-year |
| 17 | Existing | High | 100-year |
| 18 | Proposed | High | 2-year |
| 19 | Proposed | High | 25-year |
| 20 | Proposed | High | 100-year |

## Results of Hydraulic Modeling

Scenarios 3 through 20 (flooding events) showed no effect within the error limits of the model (0.1 feet, or approximately 1 inch) from any of the ELJs at all of the cross-sections along the main stem of Nookachamps Creek (Appendix C). This is because once the water escapes the narrow, confined channel, the flow fills the entire basin (Figure 1B). Any extra resistance to flow that the ELJs provide is taken up by slight increases (less than 0.1 feet/second) in the velocity in the floodplain far away from the channel.

In East Fork Nookachamps Creek, when the Skagit River is flooding, the results remain the same as in the main stem. In addition to the effect described above, the backwater of the Skagit River, when it is flooding, helps to push water out of the confined channel and into the basin at-large. However, when the Skagit River does not provide a backwater, the ELJs exert a slight influence for a 2-year event (Table 3), because for the smallest events, the flow remains somewhat confined by the topography surrounding the East Fork. The confined flow is influenced more strongly by the ELJs than the basinwide flows during larger floods. The effect of ELJs continues to be slight (approximately 1 inch) and near the limit of resolution of the model at the property boundary. A complete listing of HEC-RAS flood modeling results is provided in Appendix C.

**Table 3. Changes in water surface elevations in East Fork Nookachamps Creek.**

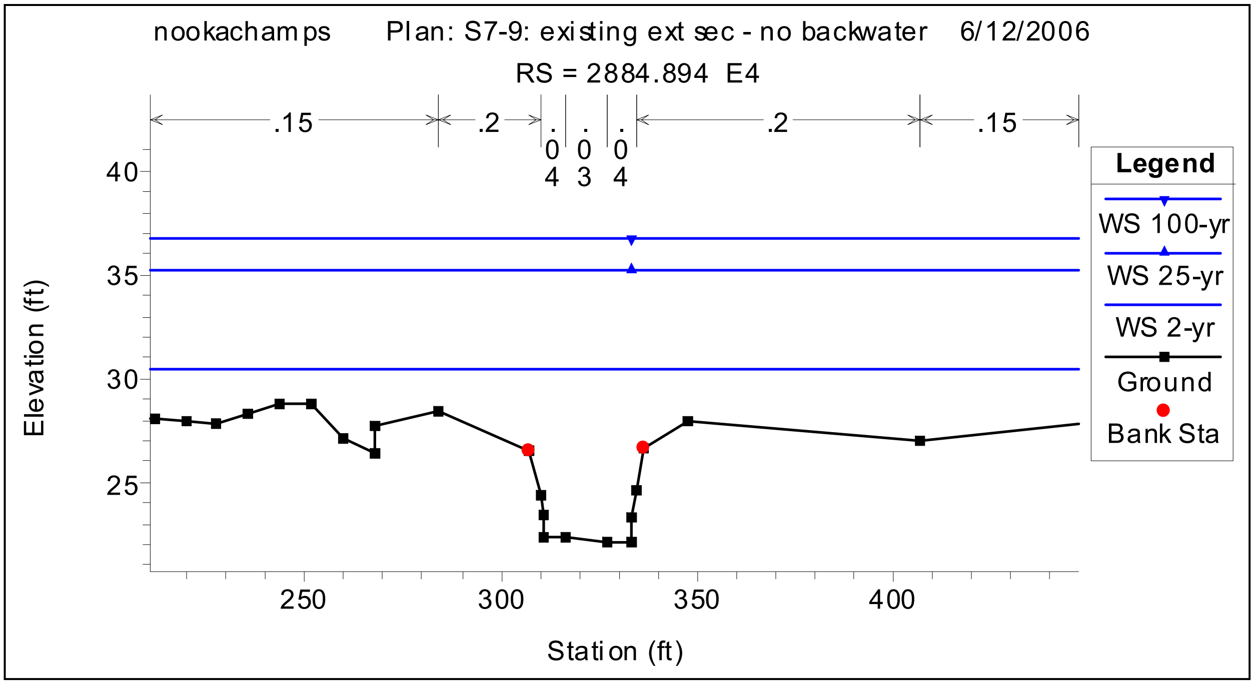
| Cross-Section Station | No Skagit Backwater (feet) | | | Moderate Skagit Backwater (feet) | | | High Skagit Backwater (feet) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2-year | 25-year | 100-year | 2-year | 25-year | 100-year | 2-year | 25-year | 100-year |
| E1 | 0.0 | 0.0 | 0.00 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | **ELJ** | | | | | |
| E2 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| E3 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| | | | | **ELJ** | | | | | |
| E4 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| E5 | 0.3 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| E6 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| E7 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| E8 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

For lower, ordinary flows, the ELJs exert a stronger influence. In a comparison of Scenarios 1 and 2, there is a difference of +1.1 feet between the existing stage and the post-ELJ stage at the property boundary (cross-section E7 [Sheet R-11 in Appendix B] and Appendix C). Again, the influence of the ELJ is greater because the flow is confined to the channel for most of the growing season. Within the channel, the ELJs provide an impediment to flow. However, the increase in stage at the property boundary is relatively insensitive to changes in average flow rates during the growing season (Appendix D). This increase in water elevation was used in the analysis of ground water hydrology.

# Ground Water Hydrology

Two years of well-height observations were made throughout the Bank Site (Sheet R-1 in Appendix B), while the streams were also gauged in five locations. The northeast corner of the site was examined in detail to characterize the ground water elevation and its correlation to streamflow. In the area of interest, Wells 10, 11, and 13 serve as a cross-stream ground water profile.

**A.**




**B.**

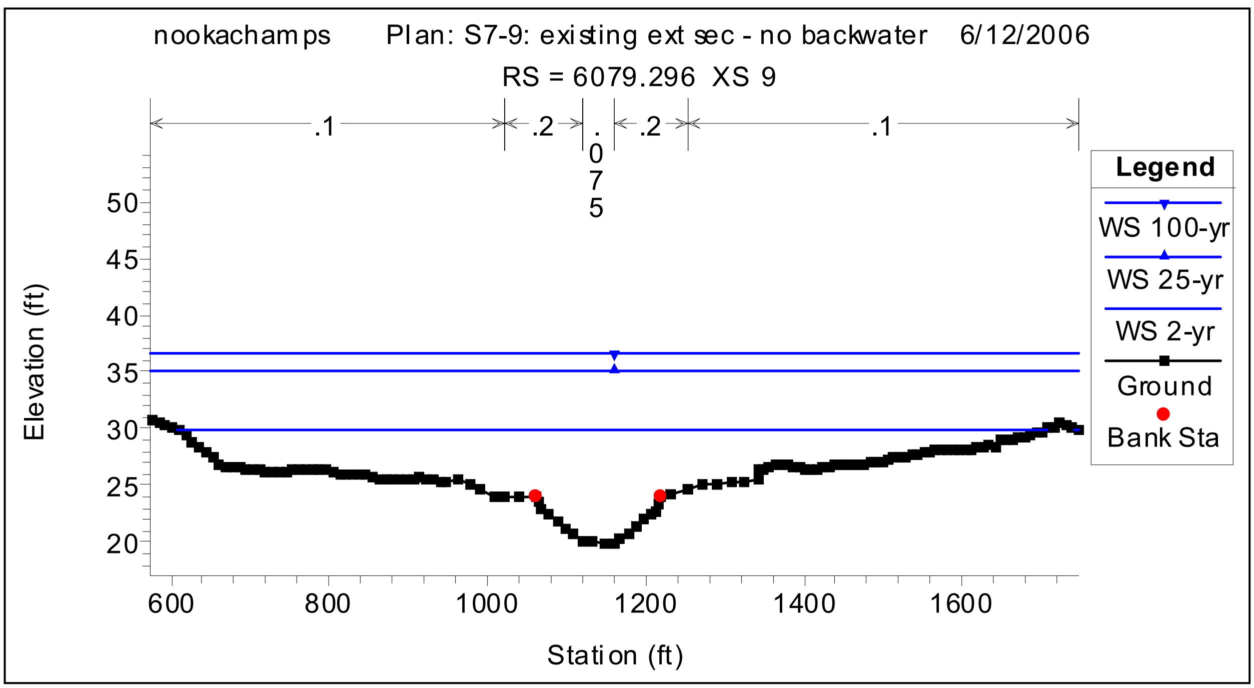



**Figure 1. Typical cross-section profiles of calibrated Manning's *n* values for (A) East Fork (E4) and (B) main stem (XS9). The *n* values are between arrows at the top of each graph. Also included are water surface elevations for the 2-year, 25-year, and 100-year flood events with no backwater and no ELJs. Locations of the profiles are shown on Sheet R-11 in Appendix B.**

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As shown in Figure 2, ground water elevation increases toward East Fork Nookachamps Creek during floods and dips towards the East Fork during drier periods. Ground water elevations far away from the streams during floods rise no more than 2 feet above their low-flow elevation, even immediately after the largest floods observed. Based on the well data (Appendices E and F), even nearby the streams, the elevation of the ground water surface persists in this heightened state for no more than a few days (Figure 3).

Ground water elevation gradients are indicators of flow. The pattern of flow seen in Figure 2 is typical near rivers, where ground water recharge occurs during floods; during drier times, ground water contributes to river base flow. This effect is limited to the area immediately surrounding East Fork Nookachamps Creek because the ground water elevations in Wells 11 and 13 are always within a few inches of one another. On East Fork Nookachamps Creek, strong influence only occurs within 300 feet of the stream (the distance between Well 11 and the East Fork: Figure 2). The ground water elevation away from the stream is dominated by the regional ground water field. In the case of the Bank Site, the regional ground water field is controlled by recharge from the Skagit River, Beaver Lake, and Clear Lake. Therefore, for areas more than 300 feet from East Fork Nookachamps Creek, any alteration of the ground water field associated with stage increases will be minimal, so long as the river base flow remains below the regional ground water elevation.

From the hydraulic modeling results above, it is apparent that only lower flows affect water surface elevations away from the structures. To ensure that ground water recharge was not occurring during low flow, Scenario 2 (a low-flow HEC-RAS simulation of East Fork Nookachamps Creek with ELJs) was compared with the ground water elevation during the growing season in the vicinity of the northeast property line. As shown in Figure 2, the ground water elevation away from the East Fork is higher than the increased stage associated with ELJs indicated by the results of the HEC-RAS model. Therefore, as shown in the figure, ground water discharge to the East Fork will continue during the growing season, regardless of the presence of ELJs in the East Fork. Locally the discharge rate may be diminished, but the reduction of discharge will be insignificant with respect to the contribution of the other water bodies that dominate regional ground water flow.

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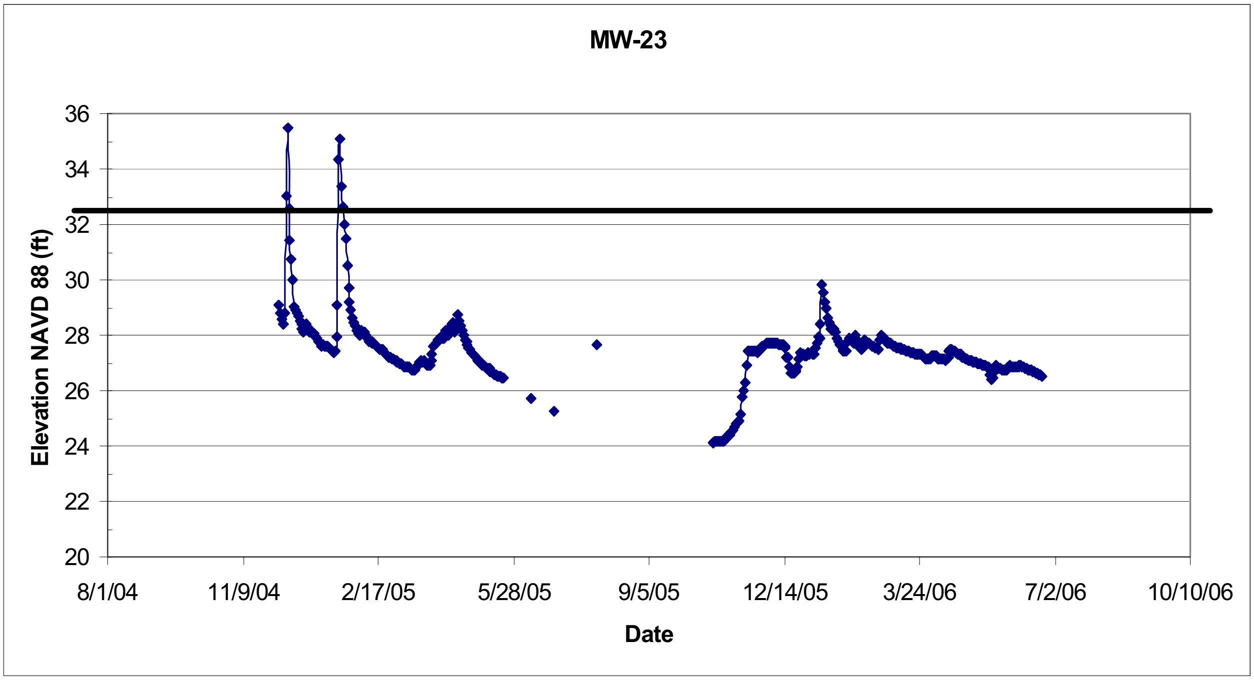
**Figure 2. Ground water profile near the east property boundary in the vicinity of East Fork Nookachamps Creek.**

8 ½ x11, color
(see Rhoda for latest version)

2nd page for color Figure 2

(A)




(B)

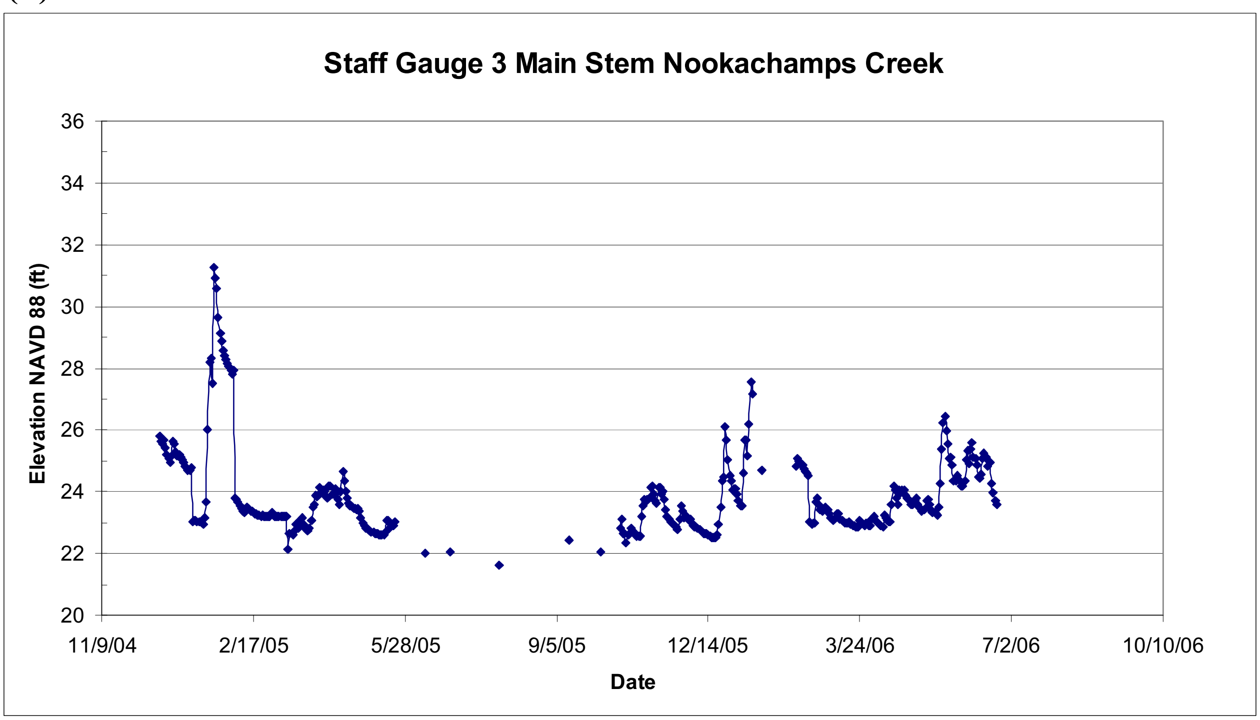



**Figure 3. Time series of (A) ground-water-elevation and (B) stage-height data. Bold black line on ground water plot is elevation of ground surface. Ground water data is unreliable due to water motion when above ground surface.**

# Implications of Proposed Project Design

The implications of the proposed project primarily relate to the increased storage of water within the Bank Site. Because of the flat topography of the Bank Site and backwater produced by the Skagit River, the effects are felt only upstream/upslope of the proposed changes. The most significant change is the roughness added by the ELJs. The ELJs raise the water level in Nookachamps Creek and East Fork Nookachamps Creek only during periods of low flow. There is no change in water levels during floods.

## Potential Locations for Bank Site Influence

### Nookachamps Creek: Downstream/North Boundary

Because the flow in Nookachamps Creek is always subcritical, the hydraulic control of Nookachamps Creek at the downstream/north boundary is always downstream. This means that the structures upstream of the downstream/north boundary have no effect on the water elevation there. In fact, because storage will be increased throughout the Bank Site, the proposed project will likely suppress flooding downstream of the Bank Site. Restoration of wetland function often results in flood-suppression benefits downstream (Zedler and Kercher 2005).

### Nookachamps Creek: Upstream/South Boundary

At the upstream/south boundary, there is a low, narrow floodplain along the stream for the first 2,000 feet south of the Bank Site. The approximately 1,500 feet of land adjacent to the Bank Site in the floodplain is owned by Environmental Solutions, LLC, a partner of the Skagit Environmental Bank. The water level in the main stem of Nookachamps Creek at the boundary of the Environmental Solutions property (XS19) is not changed by the addition of ELJs during floods or during the growing season (Appendix C). Therefore, there should no effect on the hydrology beyond the boundary of the Environmental Solutions property.

### East Fork Nookachamps Creek: Upstream/East Boundary

The upstream/east boundary is the boundary most prone to change from the addition of the ELJs. The land surface of adjacent farms is only slightly higher than the Bank Site. Public comments made available to Herrera mentioned the possibility of heightened ground water levels endangering local agriculture. Therefore, the analysis discussed in the section "Ground Water Hydrology" was performed specifically to analyze that threat. As summarized in that section, the only times that the ELJs significantly influence the stage in East Fork Nookachmaps Creek is during low flow (e.g., during the growing season). The increase in stage at those times is not sufficient to cause ground water recharge (Figure 2). Therefore, the ground water elevation, and the water content in the soil above, will be unaffected by the presence of the ELJs. Like the rest of the site, there is no measurable effect of the ELJs during floods.

### Barney Lake: Upstream/West Boundary

The portion of Barney Lake immediately adjacent to the Bank Site is owned partially by Environmental Solutions. Barney Lake retains its natural wetland function. The confluence of Barney Lake with the main stem of Nookachamps Creek is downstream of all of the ELJs. Because hydraulic control is always downstream in Nookachamps Creek, water levels within the channel will not change with the addition of the ELJs. Heightened ground water elevations on the east side of Nookachamps Creek, associated with the ELJs and the filling of drainage ditches, will be intercepted by the stream; therefore, the proposed project will have no effect on the hydrology of Barney Lake.

### College Creek: Upstream/Southwest-Corner Boundary

Like farther north at Barney Lake, Environmental Solutions owns the properties immediately adjacent to the Bank Site. At the point where College Creek leaves the Environmental Solutions property, the land surface in the channel is more than 32 feet NAVD 88. This elevation is substantially higher than any other tributary of the Bank Site, and several feet above the floodplain. As result, the influence of raised low-flow water levels due to the ELJs will be negligible at this boundary.

### Mud Creek: Upstream/Northeast-Corner Boundary

Mud Creek drains a group of properties to the northeast of the Bank Site. Filling of Mud Creek was originally considered; however, the idea was eliminated from consideration because of the possible elevation of water levels to the adjacent properties. Therefore, Mud Creek will remain unaltered and capable of conveying pre-project discharges. In fact, grading of the downstream end of Mud Creek will ease flooding upstream by lowering the downstream level of flooded water, when the Skagit River plays no role (i.e., only in extremely local, intense showers). When the Skagit is flooding, its hydrology overwhelms any effect of modifications in the Nookachamps Creek basin.

## Summary

The Proposed project will not adversely affect surface or ground water hydrology outside the project boundary during floods. At lower stages, water levels are elevated above existing levels at the upstream boundaries, but streamflow during these times is regulated by ground water discharge. Because streamflow is controlled by ground water discharge, the effect of heightened stage in the streams on the ground water hydrology is nullified. Continued monitoring of gauge locations and additional ground water monitoring wells on the upstream/east boundary, the only boundary prone to ground water influence, should confirm this hypothesis.

# References

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Cowan, W.L. 1956. Estimating Hydraulic Roughness Coefficients. Agricultural Engineering 37:437–475.

Zedler, J.B. and S. Kercher. 2005. Wetland Resources: STATUS, Trends, Ecosystem Services, and Restorability. Annual Review of Environment and Resources 30:39–74.

# APPENDIX A

## Land-Use and Reclassification-Use Map

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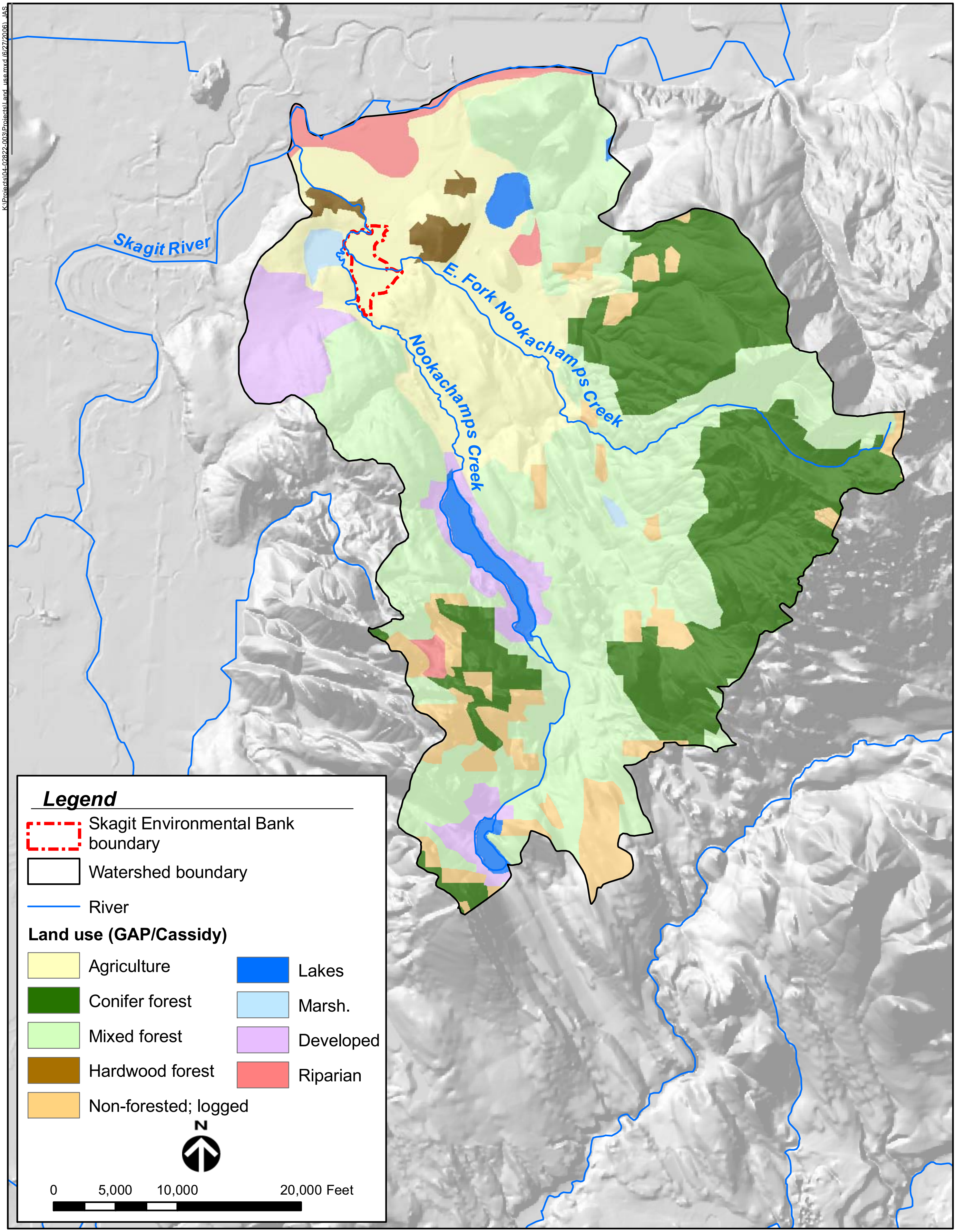


**Figure A-1. Land use map.**

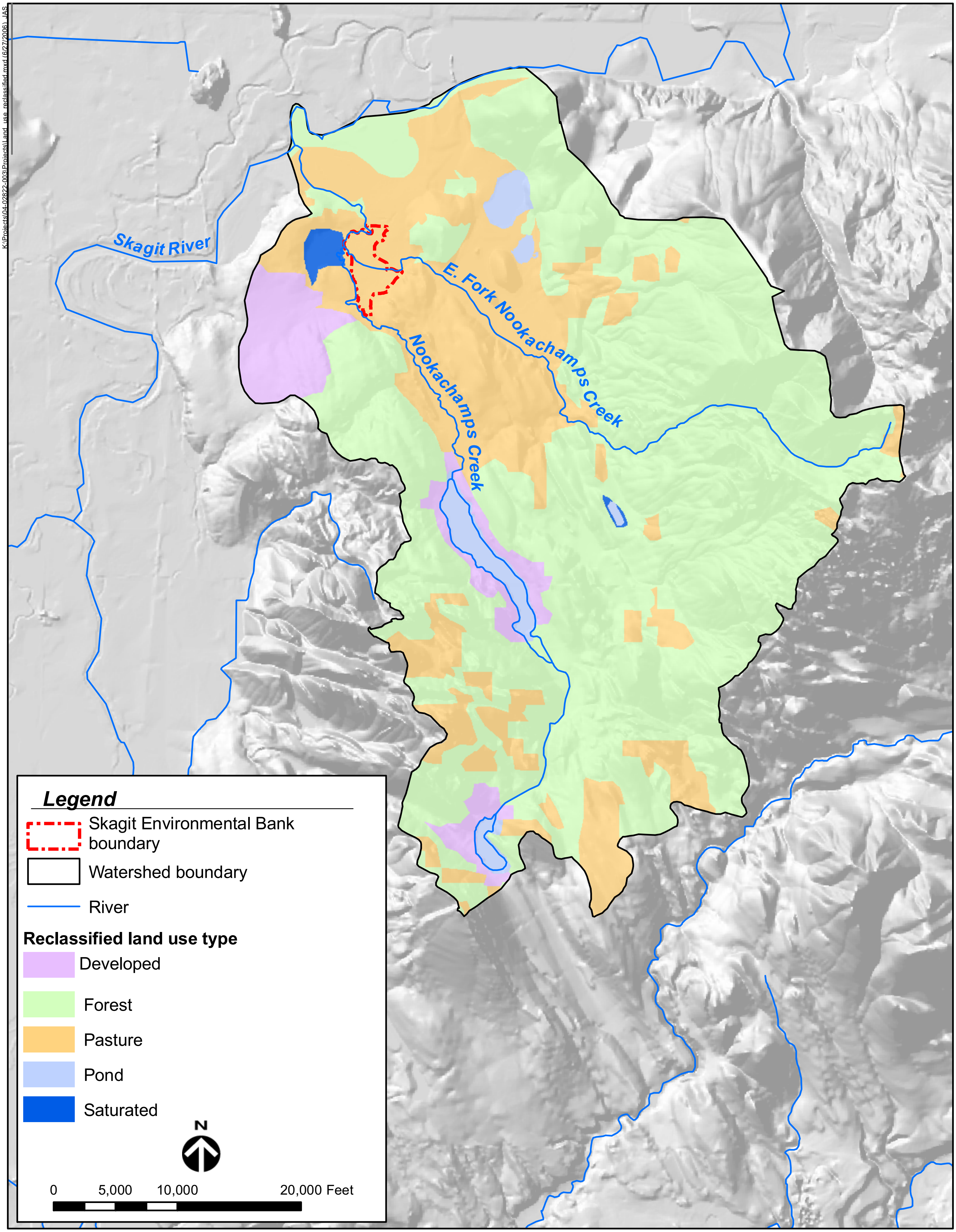


**Figure A-2. Land use reclassification map.**

**APPENDIX B**

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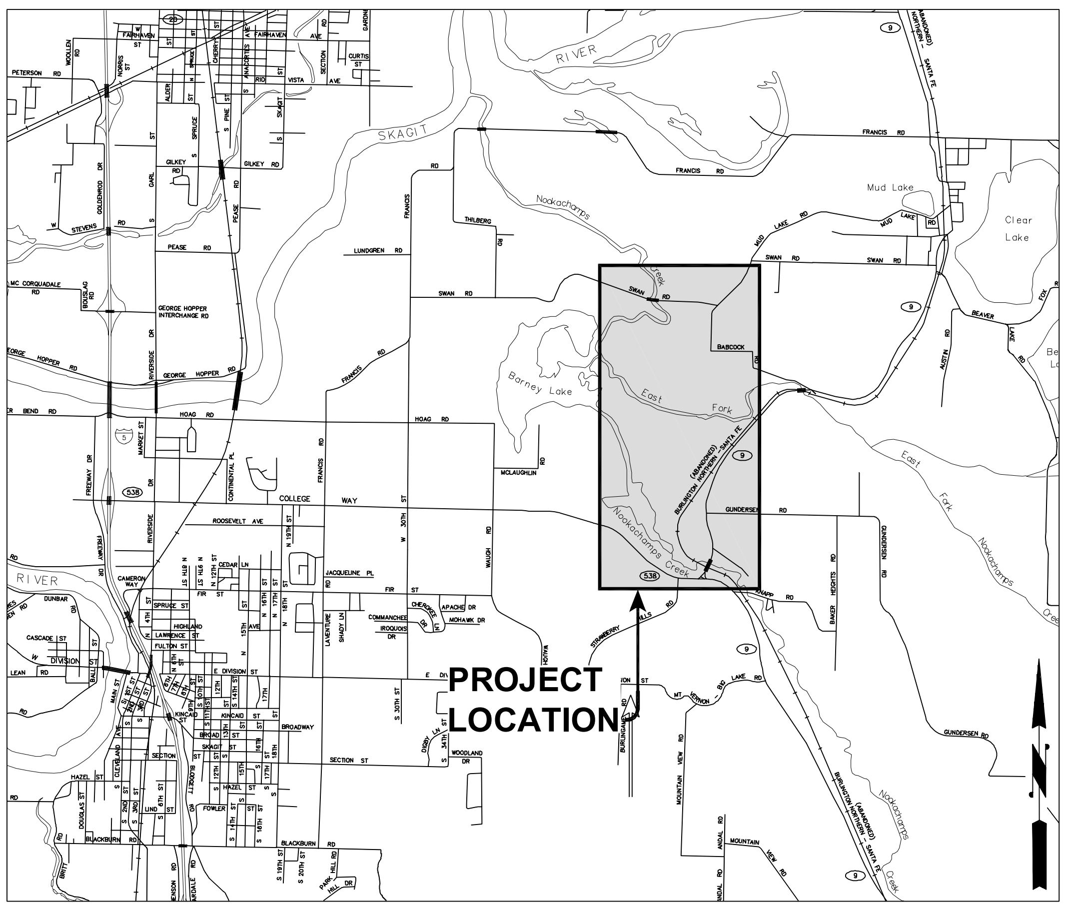
# Plan Set for Skagit Environmental Bank Hydrologic Conditions Restoration, Phase I

# SKAGIT ENVIRONMENTAL BANK
# HYDROLOGIC CONDITIONS RESTORATION
## SUSTAINABLE ENVIRONMENTS, LLC
# PHASE I

## MOUNT VERNON, WASHINGTON


LOCATION MAP
SCALE: N.T.S.




VICINITY MAP
SCALE: N.T.S.

SHEET LIST TABLE

| Sheet Title | Sheet Number | Sheet Description |
|---|---|---|
| G-1 | 1 | TITLE SHEET, INDEX & VICINITY MAP |
| G-2 | 2 | PROJECT NOTES |
| G-3 | 3 | CONSTRUCTION NOTES |
| G-4 | 4 | CONSTRUCTION NOTES |
| C-1 | 5 | EXISTING CONDITIONS AND PROPOSED STRUCTURES |
| C-2 | 6 | PHASE I SITE PLAN AND PROPOSED WORK |
| C-3 | 7 | PHASE I SITE PLAN AND PROPOSED WORK |
| C-4 | 8 | GRADING X-SECTIONS |
| C-5 | 9 | GRADING X-SECTIONS |
| C-6 | 10 | ELJ - GRADE CONTROL STRUCTURE PLAN |
| C-7 | 11 | ELJ - GRADE CONTROL STRUCTURE DETAILS |
| C-8 | 12 | ELJ - GRADE CONTROL STRUCTURE LONGITUDINAL CROSS SECTION |
| C-9 | 13 | HEAD CUT |
| ESC-1 | 14 | EROSION AND SEDIMENT CONTROL PLAN |
| ESC-2 | 15 | EROSION AND SEDIMENT CONTROL DETAILS |
| R-1 | 16 | WELL LOCATIONS (INDICATING WELL#) |
| R-2 | 17 | GW SURFACE ELEVATIONS (2ND AND 3RD QT. 2005) |
| R-3 | 18 | GW CONTOUR MAP (2ND QT. 2005) |
| R-4 | 19 | DIFFERENCE BETWEEN GROUND SURFACE AND GROUNDWATER ELEVATIONS (2ND QT. 2005) |
| R-5 | 20 | CONCEPTUAL VEGETATION COMMUNITIES |
| R-6 | 21 | PHASE II PROFILE SECTION LOCATIONS |
| R-7 | 22 | PHASE II GRADING PROFILES |
| R-8 | 23 | PHASE II GRADING PROFILES |
| R-9 | 24 | PHASE II GRADING PROFILES |
| R-10 | 25 | PHASE II GRADING PROFILES |
| R-11 | 26 | HEC RAS CROSS SECTION LOCATIONS |

1 / - DETAIL REFERENCE NUMBER
DRAWING ON WHICH DETAIL APPEARS

DETAIL
SCALE: NTS

1 / - DETAIL REFERENCE NUMBER
DRAWING FROM WHICH DETAIL WAS TAKEN

("TYP" SPECIFIES THAT DETAIL IS UNIFORMLY TYPICAL THROUGHOUT PROJECT EXCEPT WHERE OTHERWISE NOTED)
("VAR" SPECIFIES THAT DETAIL WAS TAKEN FROM SEVERAL DRAWINGS)

A / C-2 SECTION "A" IS SHOWN ON DRAWING "C-2"

SECTION
SCALE: NTS

A / - SECTION REFERENCE LETTER
DRAWING FROM WHICH SECTION WAS TAKEN

DETAIL AND SECTION REFERENCING



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

**DRAFT DESIGN**

| No. | REVISION | BY | APP'D | DATE |
|---|---|---|---|---|
| 2 | REVISION NO. 2 | MS | | 6/06 |
| 1 | REVISION NO. 1 | MS | | 5/06 |

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| | |
|---|---|
| DESIGNED: M. SPILLANE | DRAWN: T. PRESCOTT |
| DESIGNED: - | SCALE: AS NOTED |
| DESIGNED: - | CHECKED: C. BARTON |
| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE I & PHASE II

TITLE SHEET, INDEX & VICINITY MAP

JUNE 2006
04-02822-003
G-1
SHEET NO: 1 OF 26

Path: O:\proj\04-02822-003\Cad\Dwgs\Revision No 2 Set\G-1.dwg
Plot Date: 7/21/2006 2:01 PM
Cad User: Tom Griga

## OVERALL PROJECT:

1. THE BANKING PROJECT IS PLANNED TO BE CONSTRUCTED IN THREE PHASES TO EFFECT HYDROLOGIC AND HYDRAULIC MODIFICATIONS AND REFINE DESIGN TO ACTUAL SITE RESPONSE CONDITIONS.

   PHASE I – ELJ CONSTRUCTION, DITCH FILL AND COVER CROP PLANTING
   PHASE II – INITIAL SITE GRADING, CHANNEL CONSTRUCTION, PLANTING
   PHASE III – FINAL GRADING AND PLANTING

2. THE WORK IN EACH PHASE WILL BE THE INTRODUCTION OF CHANGES, PERFORMED IN A LOGICAL SEQUENCE TO MODIFY SPECIFIC FUNCTIONS OF THE ENTIRE SITE. – FUNCTIONAL PHASING.
3. PHASE I IS PLANNED TO BE CONSTRUCTED DURING THE IDENTIFIED FISH WINDOW IN 2007.
4. PHASE II AND III WILL FOLLOW PHASE I AS HYDROLOGIC AND HYDRAULIC DATA IS REVIEWED AND THE GRADING PLAN REFINED TO ENSURE PERFORANCE STANDARDS ARE ACHIEVED.

## PHASE I PROJECT WORK ELEMENTS OBJECTIVES:

1. IMPROVE FLOODPLAIN HYDROLOGIC AND HYDRAULIC CONDITIONS BY RESTORING IN-CHANNEL STREAM MORPHOLOGY AND ALTER THE GROUND WATER HYDROLOGY ON 70+% OF THE SITE BY ADDING UP TO FIVE ENGINEERED LOG JAMS (ELJ'S) IN THE NOOKACHAMPS AND EAST FORK OF THE NOOKACHAMPS AT INTERVALS TO AFFECT CHANGE IN GEOMORPHIC PROCESS AND BY FILLING IN EXISTING DRAINAGE DITCHES.
2. PLANT A COVER CROP OF HERBACEOUS PLANTS TO STABILIZE THE HYDRIC SOIL AND NON-HYDRIC SOILS.
3. COVER CROP PLANTING WILL BE A MIXTURE OF FIVE NATIVE GRASSES:

   TUFTED HAIRGRASS (DESCHAMPSIA CESPITOSA; FAC)
   MEADOWBARLEY (HORDEUM BRACHYANTHERUM; FACW)
   TALL MANNAGRASS (GLYCERIA ELATA; FACW
   CALIFORNIA BROME (BROMUS CARINATUS; UPLAND SPECIES)
   BLUE WILD RYE (ELYMUS GLAUCUS; UPLAND SPECIES)

4. SEEDING RATES WILL BE 10 TO 12 POUNDS PER ACRE FOR TWO PLANT SPECIES AND 1 POUND PER ACRES FOR THE OTHER SPECIES IN THE MIX.
5. PLANTING WILL BE PERFORMED IMMEDIATELY FOLLOWING HYDRAULIC AND HYDROLOGIC MODIFICATIONS (INSTALLATION OF ELJ'S AND DITCH FILLING)

## PROJECT AREA:

1. THE PROJECT SITE IS 370 ACRES INCLUDING THE BANK BUFFER AREA. TOTAL DOES NOT INCLUDE EASEMENTS OF 4 ACRES.
2. THE BUFFER BOUNDARY IS SHOWN AS 150 FEET ALONG THE NORTH AND NORTHWEST EDGE OF THE BANK AND NORTHERN REACH OF THE NOOKACHAMPS.
3. THE BUFFER BOUNDARY IS SHOWN AS 150 FEET FROM THE NORTH ALONG THE EAST EDGE OF THE BANK DOWN TO THE EAST FORK OF THE NOOKACHAMPS.
4. THE REMAINING BUFFER BOUNDARY IS SHOWN AS 50 FEET.
5. THE SITE IS ACCESSED FROM THE EAST BY STATE ROUTE 9.
6. THE SITE IS ACCESSED FROM THE WEST BY MCLAUGHPLIN EXTENTION ROAD.
7. TWO STEAMS PASS THROUGH THE SITE – THE NOOKACHAMPS AND THE EAST FORK OF THE NOOKACHAMPS.

## GROUND WATER WELLS:

1. GROUND WATER WELLS HAVE BEEN INSTALLED THROUGHOUT THE BANK SITE. SEE SHEET R-1 FOR WELL LOCATIONS.
2. THIRTY THREE (33) WELLS HAVE BEEN INSTALLED AND MONITORED MONTHLY DURING 2005.
3. AVERAGED 2ND QUARTER (APRIL/MAY/JUNE) AND 3RD QUARTER (JULY/AUGUST/SEPTEMBER) GROUND WATER ELEVATION DATA FROM 2005 IS SHOWN ON SHEET R-2.
4. SHEET R-3 IS A 2ND QUARTER 2005 GROUND WATER ELEVATION CONTOUR MAP.
5. SHEET R-4 IS A CONTOUR MAP SHOWING DEPTH TO GROUND WATER FROM EXISTING GRADE USING AVERAGED 2ND QUARTER 2005 DATA.

## REFERENCE WETLAND VEGETATION DATA:

1. WELLS HAVE BEEN INSTALLED IN REPRESENTATVIE VEGETATION COMMUNITIES (I.E. EMERGENT, SCRUB/SHRUB, AND FORESTED WETLAND) ONSITE.
2. WATER LEVEL DATA COLLECTED DURING THE SECOND QUARTER OF 2005 (APRIL/MAY/JUNE) FROM THE FOLLOWING WELLS WAS USED TO DELINEATE PROPOSED WETLAND COMMUNITES:

| | |
|---|---|
| EMERGENT | -18 TO -5 CM (MW-2) |
| SCRUB/SHRUB | -2 TO 20 CM TO GROUND WATER (MW-2, 3 AND 27 ) |
| FORESTED | 23 TO 38 CM TO GROUND WATER (MW-3,5 AND 26) |

   NOTE: A NEGATIVE NUMBER INDICATES STANDING WATER

3. PROPOSED WETLAND COMMUNITIES ARE BASED ON AVERAGE DEPTH TO GROUND WATER FROM EXISTING GROUND ELEVATION, VEGETATION HYDROLOGIC PREFRERENCES, EXISTING TOPOGRAPHY, AND SUBSTRATE.

## PROPOSED WETLAND CLASSIFICATIONS:

1. SEE SHEET R-5. THE PROPOSED WETLAND CLASSIFICATIONS THAT WILL RESULT FROM COMPLETION OF ALL PHASES ARE:

| | ACRES | PERCENTAGE |
|---|---|---|
| SYSTEM: PALUSTRINE, CLASS: EMERGENT | (68) | (18%) |
| SYSTEM: PALUSTRINE, CLASS: SCRUB-SHRUB | (68) | (18%) |
| SYSTEM: PALUSTRINE, CLASS: FORESTED | (125) | (34%) |
| UPLAND: FORESTED ISLANDS | (109) | (30%) |
| | TOTAL= 370 | TOTAL= 100% |

   NOTE: EMERGENT INCLUDES 13 ACRES OF RIVERINE.

2. IN DESIGNING THE LOCATIONS OF THE PROPOSED WETLAND AREA POLYGONS, ON-SITE PLANT REFERENCE SITE DATA WILL BE USED TO DETERMINE HYDROLOGY REQUIRED TO ACHIEVE THE BANK PERFORMANCE STANDARDS.
3. SEE SHEET R-1 FOR EXISTING WETLAND AREAS.
4. SITE GRADING WILL BE BASED ON EFFECTED GROUND WATER ELEVATIONS THAT WILL SUPPORT THE PLANTING DISTRIBUTION. SEE SHEET R-4 FOR SOIL EXCAVATION TO GROUND WATER FROM EXITING SURFACE. THIS DATA IS BASED ON 2ND QUARTER GROUND 2005 WATER ELEVATIONS.
5. SEE SHEET R-5 FOR PHASE II CONCEPTUAL VEGETATION COMMUNITIES.



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SKAGIT ENVIRONMENTAL BANK
PHASE I

PROJECT NOTES

JUNE 2006
04-02822-003
G-2
SHEET NO: 2 OF 26

## WORK SEQUENCE NOTES:

1. THIS WORK SEQUENCE PLAN IS SHOWN FOR GENERAL UNDERSTANDING OF THE PROJECT CONSTRAINTS IN RELATION TO CONSTRUCTION OF ENGINEERED LOG JAMS AND RELATED SITE ACTIVITY. CONTRACTOR IS RESPOSIBLE FOR INCORPORATING ALL EXISTING AND NEW MATERIALS INTO STRUCTURES AS NECESSARY.
2. A DETAILED ELJ WORK SEQUENCE AND PHASING PLAN SHALL BE DEVELOPED BY THE CONTRACTOR AND SUBMITTED FOR APPROVAL BY THE ENGINEER. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH THE PLANS AND THE CONTRACTOR'S APPROVED ELJ WORK SEQUENCE AND PHASING PLAN.
3. IN GENERAL, THE WORK SHALL BE SEQUENCED AND PERFORMED IN A MANNER THAT MINIMIZES IMPACTS TO THE CREEK AND AREA SURROUNDING THE WORK SITE.
4. INSTALL TESC MEASURES AS SHOWN ON ESC-1 AND ESC-2.
5. CONSTRUCT TEMPORARY ACCESS ROAD TO ACCESS WORK AREA.
6. CLEAR AND PREPARE STAGING AND STORAGE AREAS AS NECESSARY (DRAWING G-3).
7. INSTALL FISH BLOCKNETS. CONTRACTOR SHALL INFORM THE PROJECT BIOLOGIST THAT THE NETS HAVE BEEN INSTALLED.
8. ALLOW THE PROJECT BIOLOGIST SUFFICENT TIME TO CLEAR REACH OF FISH. ALL FISH HANDLING ACTIVITIES TO BE DONE BY THE PROJECT BIOLOGIST.
9. BEGIN DEWATERING ACTIVITIES AS NEEDED.

## SHORING AND DEWATERING NOTES:

1. GROUND WATER WILL BE ENCOUNTERED IN EXCAVATIONS. CONTRACTOR SHALL DEWATER AS NECESSARY FOR CONSTRUCTION AND INSPECTION.
2. CONTRACTOR SHALL DEWATER EXCAVATIONS AS NEEDED TO PROVIDE ADEQUATE EXCAVATION DEPTH TO ALLOW WOOD PLACEMENT. VERTICAL PILES MAY BE DRIVEN USING VIBRATORY TECHNIQUES.
3. CONTRACTOR SHALL DESIGN ALL REQUIRED SHORING AND WATER EXCLUSION STRUCTURES. HYDROSTATIC PRESSURES SHALL BE ADDED TO LATERAL PRESSURES DUE TO EARTH, SURCHARGES AND SPECIAL PRESSURES. SPECIAL PRESSURES MAY INCLUDE BUT ARE NOT LIMITED TO HYDROSTATIC PRESSURES RESULTING FROM BACKWATER CONDITIONS, TEMPORARY SHORING SEEPAGE, MACHINERY SURCHARGE AND FLUCTUATING GROUND WATER.
4. OTHER SURCHARGES SHALL BE DETERMINED BY THE CONTRACTOR ON THE BASIS OF CONSTRUCTION TRAFFIC, EQUIPMENT STORAGE, SPOILS HANDLING, WORK SEQUENCE AND OTHER FACTORS.
5. ALL TEMPORARY SHORING SYSTEMS SHALL BE DESIGNED WITH A MINIMUM FACTOR OF SAFETY OF 1.4 (FS=1.4)

## DITCH FILLING NOTES:

1. DITCHES WILL BE FILLED WITH MATERIAL FROM ADJACENT BERMS.
2. WHERE ADJACENT BERM VOLUMES ARE NOT SUFFICIENT TO FILL DITCHES, ANTICIPATED LOCATIONS OF PHASE 2 CHANNELS WILL BE GENTLY GRADED FOR MATERIAL.
3. ALL BERMS AND AREAS GRADED FOR MATERIAL TO FILL DITCHES WILL BE STRIPPED OF VEGETATION PRIOR TO GRADING.
4. VEGETATIVE MATERIAL REMOVED DURING STRIPPING WILL BE COMPOSTED IN UPLAND AREAS.
5. ALL DISTURBED AREAS ASSOCIATED WITH DITCH FILLING WILL BE REPLANTED WITH TEMPORARY EROSION CONTROL VEGETATION AND LATER WITH WETLAND PLANTS.
6. WHERE DITCHES TERMINATE AT STREAM BANKS, HEAD CUT PREVENTION STRUCTURES WILL BE INSTALLED.

## WATER MANAGEMENT NOTES:

1. EXCAVATIONS THAT HAVE THE POTENTIAL TO IMPACT THE WETTED CHANNEL SHALL BE ISOLATED FROM THE ACTIVE CHANNEL. ISOLATION MEANS SHALL CONSIST OF SILT BOOMS, SHEET PILE, BULK BAGS, BLADDER DAMS OR OTHERS AS NECESSARY TO PREVENT IMPACTS TO WATER QUALITY.
2. SEE SHEETS ESC-1 AND ESC-2 FOR ADDITIONAL NOTES AND TYPICAL DRAWINGS FOR EROSION AND SEDIMENTATION CONTROL. WATER PUMPED FROM EXCAVATED AREA SHALL BE RELEASED TO THE EXISTING STORMWATER PONDS. THE WATER SHALL NOT BE DIRECTLY DISCHARGED.
3. ANY DEWATER ACTIVITIES SHALL NOT IMPACT WATER QUALITY.
4. CONSTRUCTION DEWATERING SHALL BE MAINTAINED 24 HOURS PER DAY DURING CONSTRUCTION, PUMPS SHALL BE MAINTAINED BY THE CONTRACTOR DURING WORKING AND NON-WORKING HOURS.
5. DIVERSION CHANNELS SHALL BE LINED WITH 15 MIL PE LINER OR APPROVED EQUAL, TO PREVENT EROSION.

## GENERAL CONSTRUCTION NOTES:

1. WORK INCLUDES CONSTRUCTION OF FOUR ENGINEERED LOG JAM (ELJ) STRUCTURES AS SHOWN ON THE PLANS. STRUCTURES ARE TO BE CONSTRUCTED INSTREAM.
2. SLASH SHALL BE COMPRISED OF TREES, LIMBS, ROOTS ROOTWADS, STUMPS, BRUSH AND OTHER MATERIAL GENERATED DURING LAND CLEARING. SLASH MATERIAL MAY BE OF VARIOUS SIZES < 12" DIAMETER. SLASH MATERIALS SHALL NOT CONTAIN COBBLES. AGGREGATE MATERIAL PASSING A TWO INCH SEIVE (SANDS AND GRAVELS) SHALL NOT EXCEEDE 5% OF THE TOTAL SLASH MATERIAL BY VOLUME AND SHALL NOT CONTAIN SILTY OR CLAYEY MATERIAL THAT WILL IN THE OPINION OF THE ENGINEER, CAUSE EXCESSIVE TURBIDITY WHEN THE WATERS OF CREEK CONTACT THE MATERIAL.
3. CONSTRUCTION MATERIAL STAGING AREAS TO BE LOCATED AS SHOWN ON THE PLANS. MATERIAL SHALL NOT BE STORED OUTSIDE OF IDENTIFIED STAGING AREAS. THE CONTRACTOR SHALL PROTECT MATERIALS FROM DAMAGE AT ALL TIMES.
4. THE CONTRACTOR SHALL LIMIT MACHINERY MOVEMENT TO CONSTRUCTION AREAS DEFINED ON PLANS OR IDENTIFIED AS ACCEPTABLE BY ENGINEER.
5. CLEARING LIMITS SHALL NOT BE EXPANDED UNLESS APPROVED BY ENGINEER.
6. CONTRACTOR SHALL DEWATER EXCAVATIONS AS NEEDED TO ENABLE PLACEMENT OF KEY LOGS AND PILES.
7. WATER PUMPED FROM EXCAVATED AREAS SHALL BE RELEASED TO UPGRADIENT AREAS (SEE SHEETS ESC-1 AND ESC-2). TURBID WATER FROM THE EXCAVATION SHALL NOT BE DIRECTLY DISCHARGED TO CREEK AT ANY TIME.
8. WATER PUMPED FROM CREEK UPSTREAM OF THE CONSTRUCTION AREA SHALL BE PUMPED TO AN ENERGY DISSIPATION STRUCTURE DOWNSTREAM OF THE CONSTRUCTION AREA (SEE SHEETS ESC-1 AND ESC-2). THE UPSTREAM INTAKE FOR THE WATER PUMPS SHALL BE ISOLATED FROM THE STREAM BY A FISH BLOCK NET. ADDITIONALLY THE PUMP INTAKE HOSE SHALL HAVE A SCREEN CONFORMING TO WDFW GUIDELINES.
9. EXCAVATIONS SHALL BE INSPECTED BY ENGINEER PRIOR TO PLACING ANY ELJ MATERIALS.
10. CONTRACTOR SHALL REMOVE ANY AND ALL EQUIPMENT, UNUSED MATERIALS AND TEMPORARY FACILITIES FROM SITE UPON COMPLETION OF WORK.



ONE INCH
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| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE I

CONSTRUCTION NOTES

JUNE 2006
04-02822-003
G-3
SHEET NO: 3 OF 26

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## VEGETATION NOTES:

1. DISTURBED AND UNPLANTED AREAS WILL BE SEEDED WITH A COVER CROP CONSISTINCY OF THE FOLLOWING:

| Species (common name) | Scientific Name | Wetland Indicator Status | Total application amount (pounds) | Application rate (pounds per acre). |
|---|---|---|---|---|
| TUFTED HAIRGRASS | *DESCHAMPSIA CESPITOSA* | FAC | 1,000 | 2.840 |
| MEADOW BARLEY | *HORDEUM BRACHYANTHERUM* | FACW | 300 | 0.850 |
| WESTERN MANNAGRASS | *GLYCERIA OCCIDENTALIS* | FACW | 3,000 | 8.520 |
| CALIFORNIA BROME | *BROMUS CARINATUS* | UPL | 2,000 | 5.680 |
| BLUE WILDRYE | *ELYMUS GLAUCUS* | UPL | 1,800 | 5.110 |
| WATER FOXTAIL | *ALOPECURUS GENICULATUS* | OBL | 200 | 0.570 |
| AMERICAN SLOUGHGRASS | *BECKMANNIA SYZIGACHNE* | OBL | 500 | 1.420 |
| **TOTAL** | | | 8,800 | 25.000 |

## NOTE:

1. PROPORTION OF TOTAL APPLICATION AMOUNTS BASED ON RELATIVE AVAILIBILITY OF SPECIES AS OF 2ND QUARTER 2006.

## ABBREVIATIONS:

FAC - FACULTATIVE

FACW - FACULTATIVE WETLAND

UPL - UPLAND

OBL - OBLIGATE WETLAND



ONE INCH

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SKAGIT ENVIRONMENTAL BANK
PHASE I

CONSTRUCTION NOTES

JUNE 2006

04-02822-003

G-4



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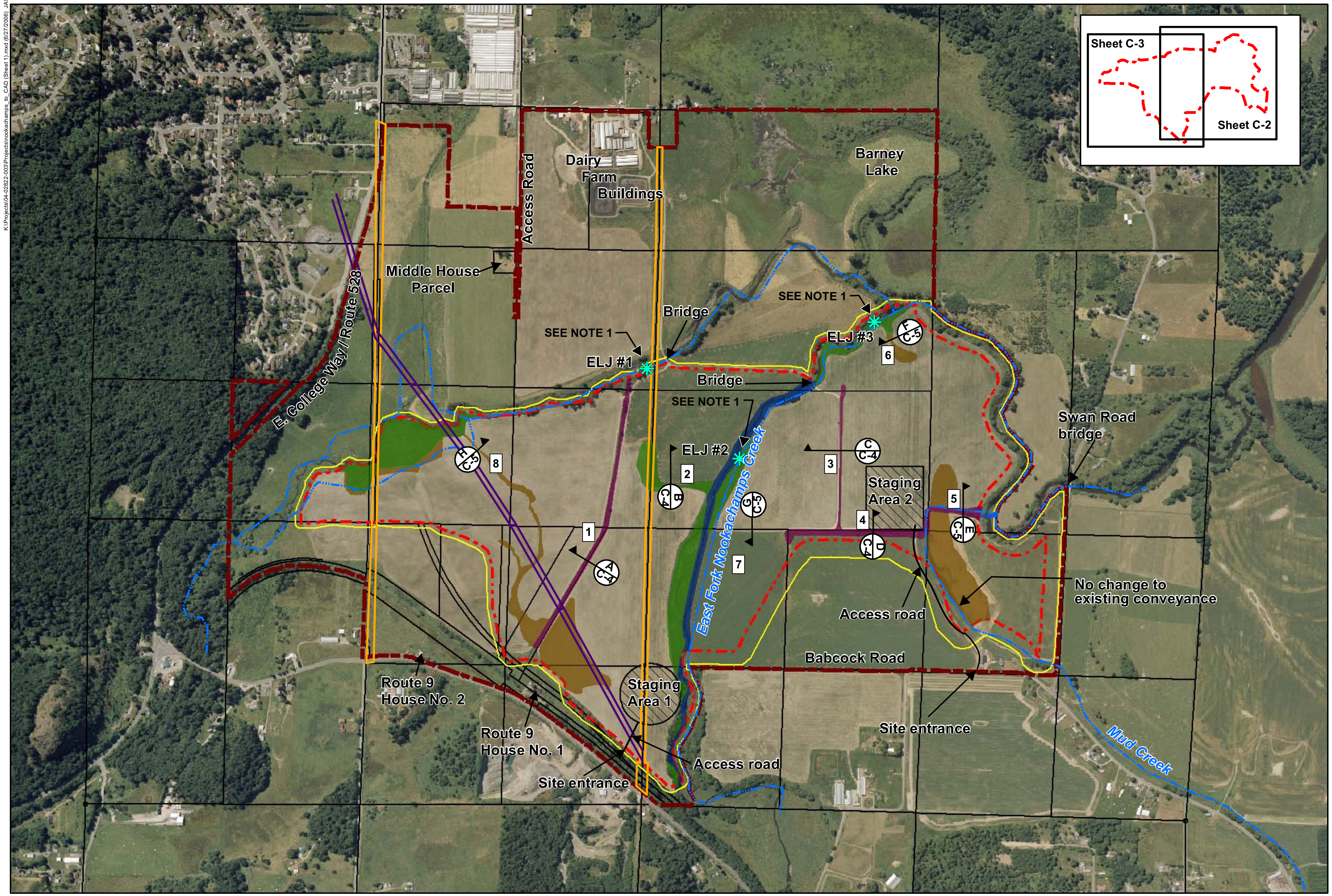


0 500 1,000 2,000 ft

1 in = 1000 ft

N

## Legend :

- Ditch number
- ELJ - Grade control structure
- Cross-section location
- Staging area
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine

**Notes:**

1. **Engineered Log Jam locations may adjust based on groundwater monitoring data.**



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# SKAGIT ENVIRONMENTAL BANK

## PHASE I

## EXISTING CONDITIONS AND PROPOSED STRUCTURES

| | |
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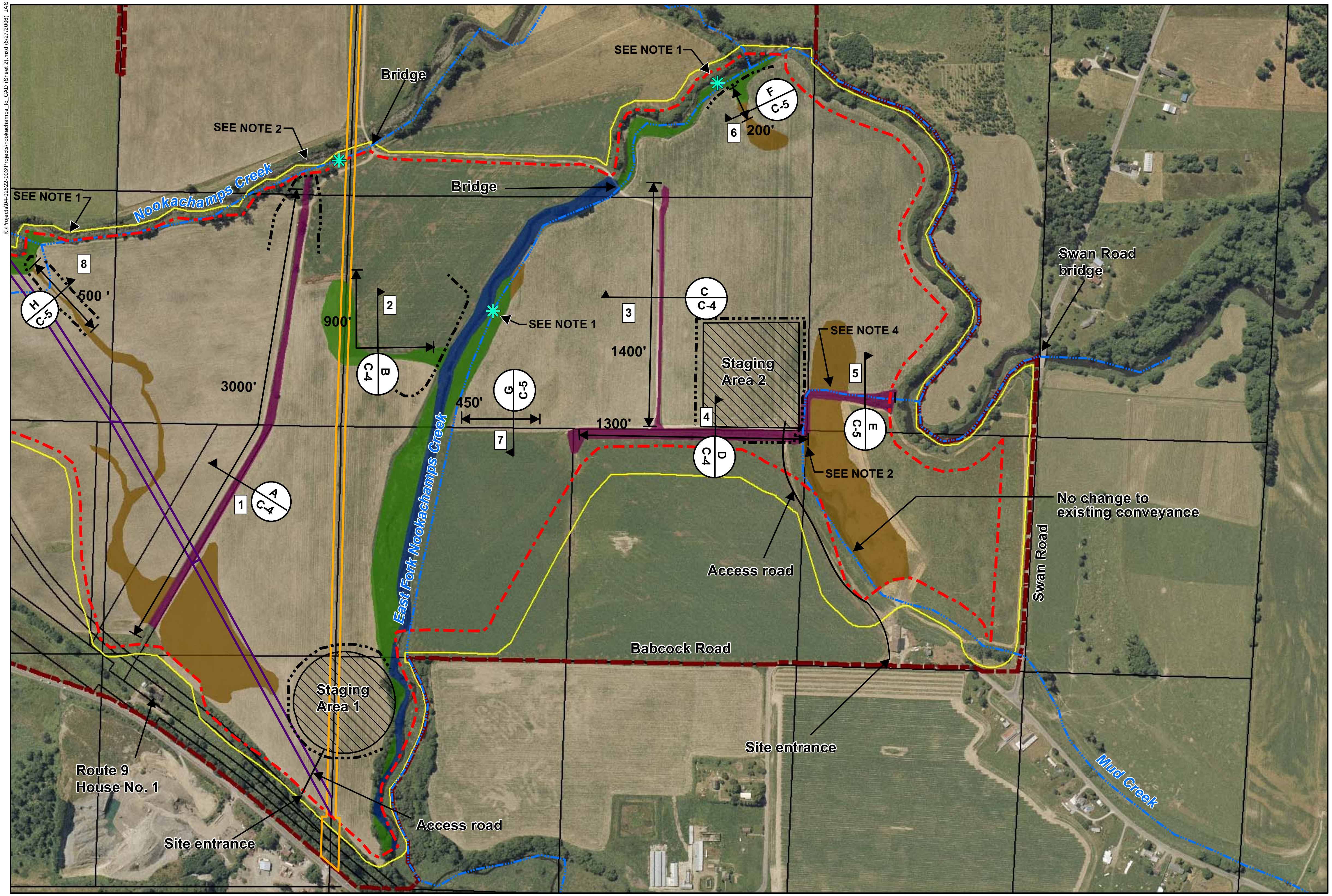
| DATE: | JUNE 2006 |
| PROJECT NO: | 04-02822-003 |
| DRAWING NO: | C-1 |
| SHEET NO: | 5 of 26 |




0 300 600 1,200 ft

1 in = 600 ft

## Legend :

- ELJ - Grade control structure
- Cross-section location and reference sheet
- 450' Existing ditch length to be filled (ft)
- 1 Ditch number
- Staging area
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary
- Silt fence

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine

**Notes:**

1. Grade control structure locations may adjust based on groundwater monitoring data.
2. Construct head cut protection at the end of all ditches when filled.
3. Install temporary silt fence at ends of each ditch.
4. No fill in Ditch 5.





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# SKAGIT ENVIRONMENTAL BANK

## PHASE I
## SITE PLAN AND PROPOSED WORK

| | |
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| DATE: | JUNE 2006 |
| PROJECT NO: | 04-02822-003 |
| DRAWING NO: | C-2 |
| SHEET NO: | 6 of 26 |

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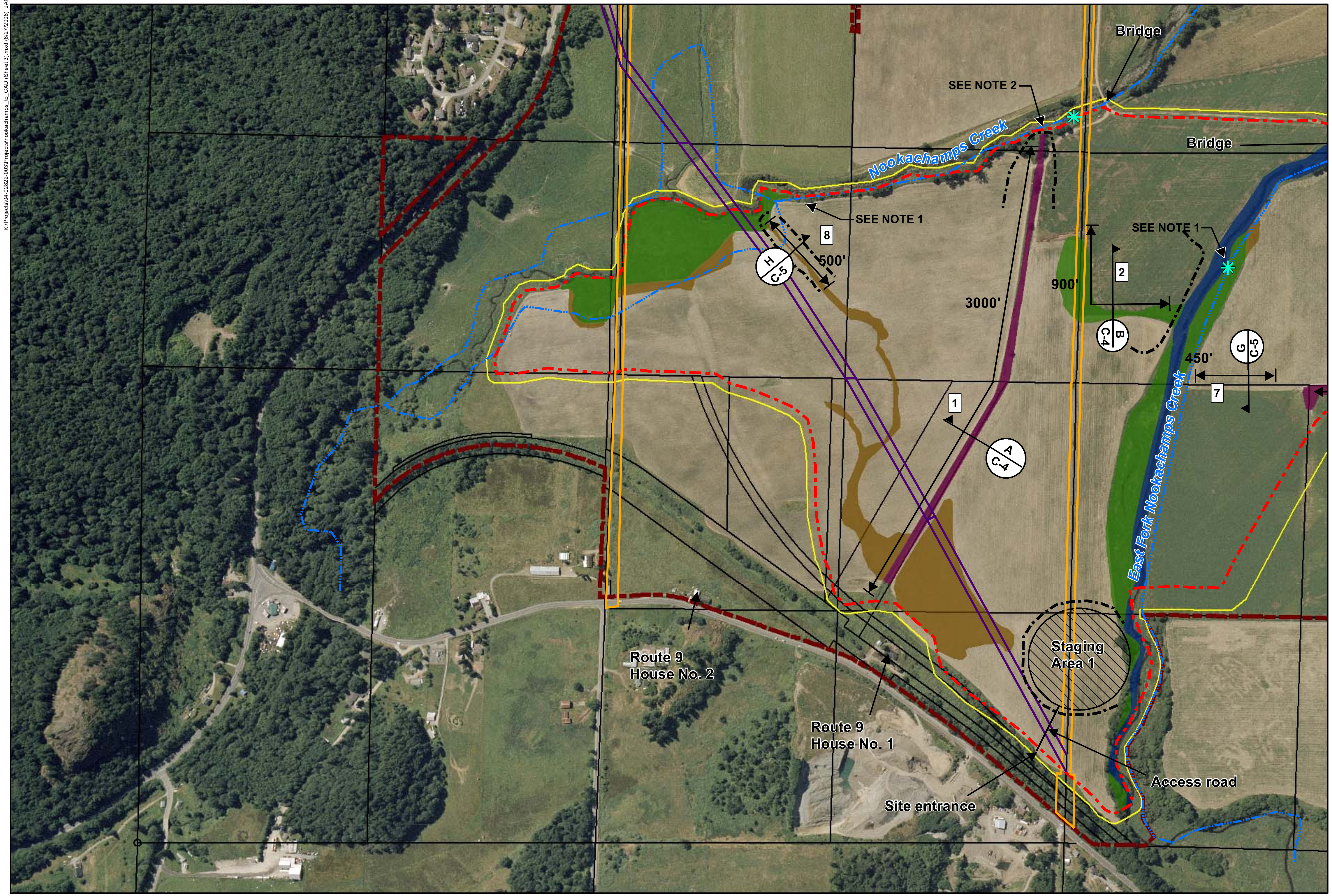


0 300 600 1,200 ft

1 in = 600 ft

N

## *Legend :*

- ELJ - Grade control structure
- A C-4 Cross-section location and reference sheet
- 450' Existing ditch length to be filled (ft)
- 1 Ditch number
- Staging area
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary
- Silt fence

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine

**Notes:**

1. **Grade control structure locations may adjust based on groundwater monitoring data.**
2. **Construct head cut protection at the end of all ditches when filled.**
3. **Install temporary silt fence at ends of each ditch.**



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# SKAGIT ENVIRONMENTAL BANK

**PHASE I**
**SITE PLAN AND PROPOSED WORK**

| | |
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| DATE: | JUNE 2006 |
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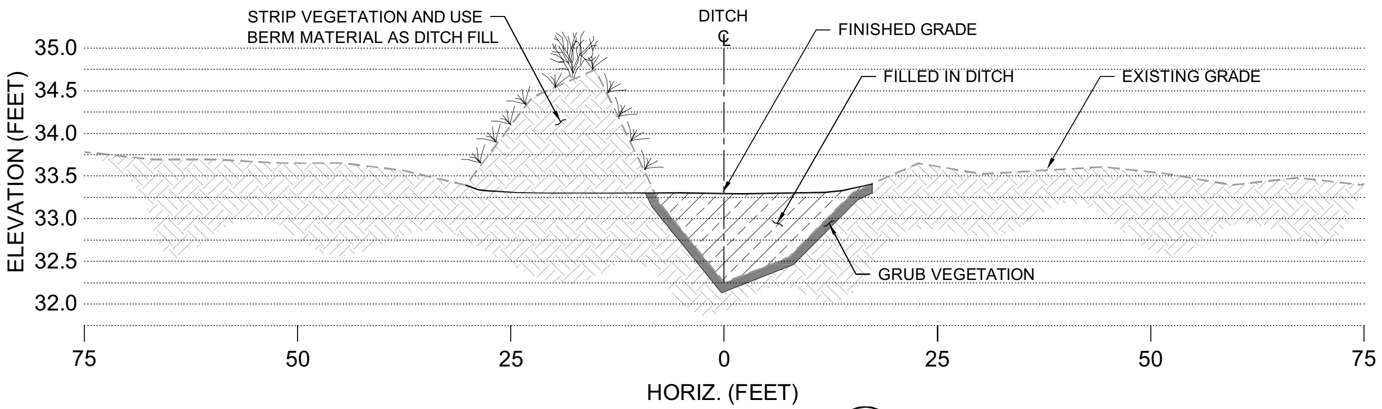
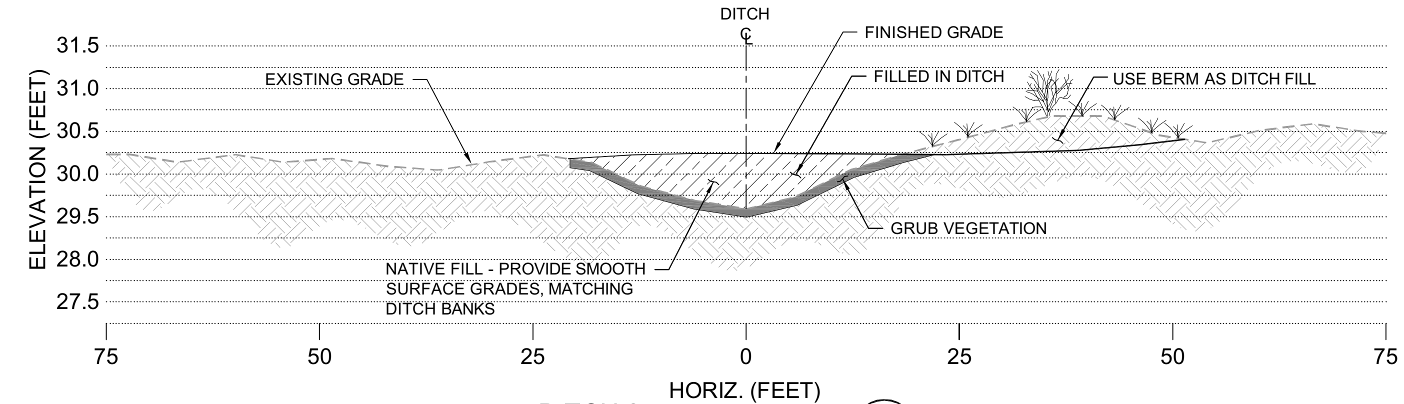
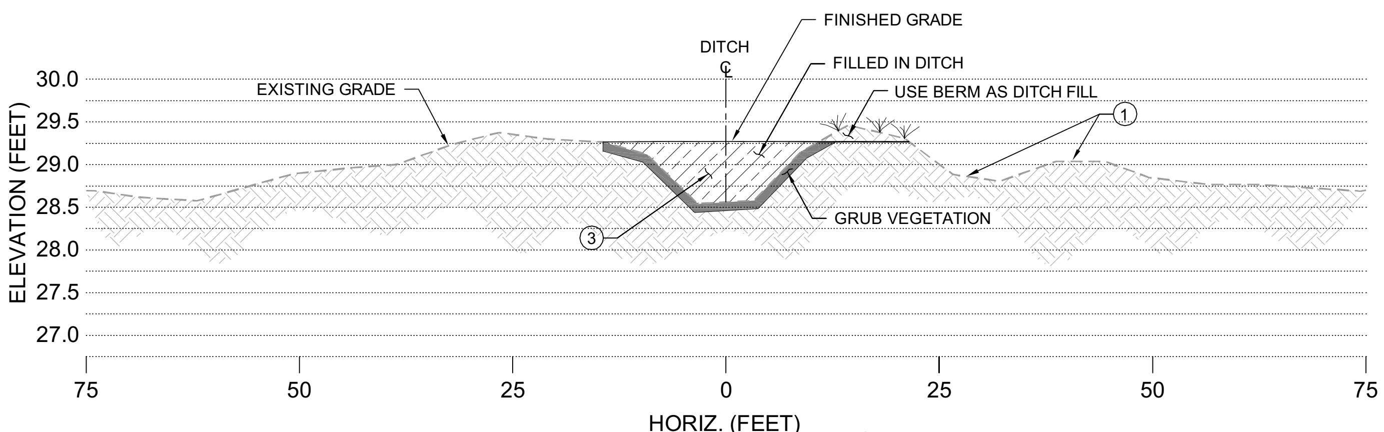
| SHEET NO: | 7 of 26 |



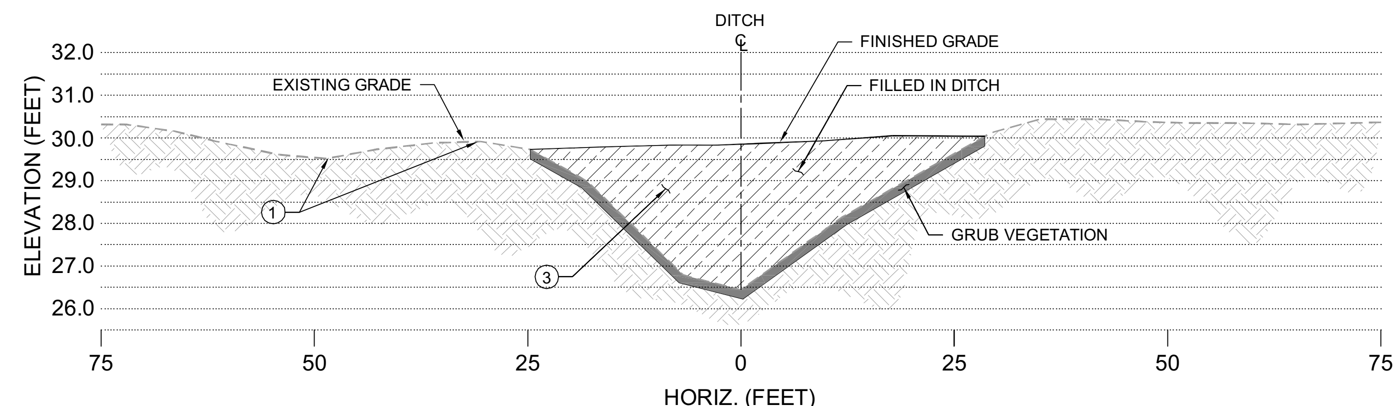

DITCH 1 (A/-)
SCALE: N.T.S.




DITCH 2 (B/-)
SCALE: N.T.S.




DITCH 3 (C/-)
SCALE: N.T.S.




DITCH 4 (D/-)
SCALE: N.T.S.

## CROSS SECTION NOTES:

1. FINISHED GRADE SHALL BE FREE OF DIPS, DEPRESSIONS, OR MOUNDS.
2. CUT AND FILL LINES ARE SHOWN GRAPHICALLY ONLY AND DO NOT REFLECT GRADING LIMITS REQUIRED TO MEET VOLUMES INDICATED IN DITCH TABLE.
3. SEE DITCH FILLING NOTES ON DRAWING G-3.
4. ELEVATIONS REFERENCE DISTANCE IN FEET ABOVE MEAN SEA LEVEL, VERTICAL DATUM NAVD 88.

## DITCH TABLE:

| DITCH ID # | DITCH LENGTH (FT) | DITCH WIDTH (FT) | DITCH DEPTH (FT) | DITCH VOLUME (CY) | BERM VOLUME (CY) | EXCESS FILL NEEDED (CY) |
|---|---|---|---|---|---|---|
| 1 | 3000 | 30 | 1 | 2267 | 1858 | 408 |
| 2 | 900 | 36 | 0.6 | 351 | 246 | 105 |
| 3 | 1400 | 18 | 0.6 | 272 | 252 | 20 |
| 4 | 1300 | 66 | 5 | 8716 | 0 | 8716 |
| 5 | 800 | 54.2 | 7.1 | 0 | 0 | 0 |
| 6 | 200 | 31.0 | 2 | 259 | 51 | 208 |
| 7 | 450 | 66.1 | 1.0 | 551 | 380 | 171 |
| 8 | 500 | 97.3 | 1.4 | 1261 | 0 | 1261 |
| TOTALS | 8550 | | | 13677 | 2787 | 10890 |

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# SKAGIT ENVIRONMENTAL BANK PHASE I

GRADING CROSS-SECTIONS

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04-02822-003
C-4
SHEET NO: 8 OF 26

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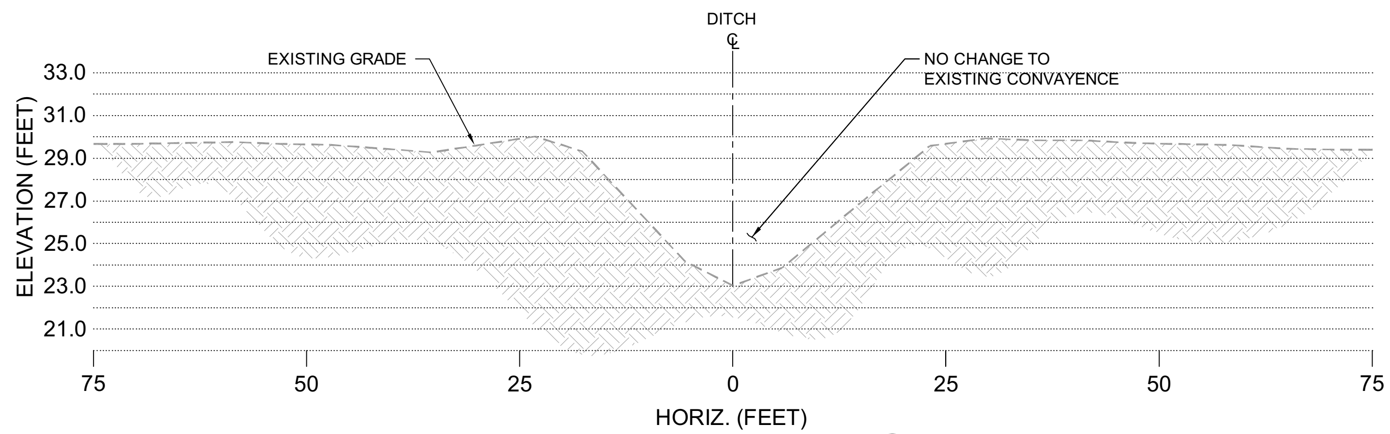
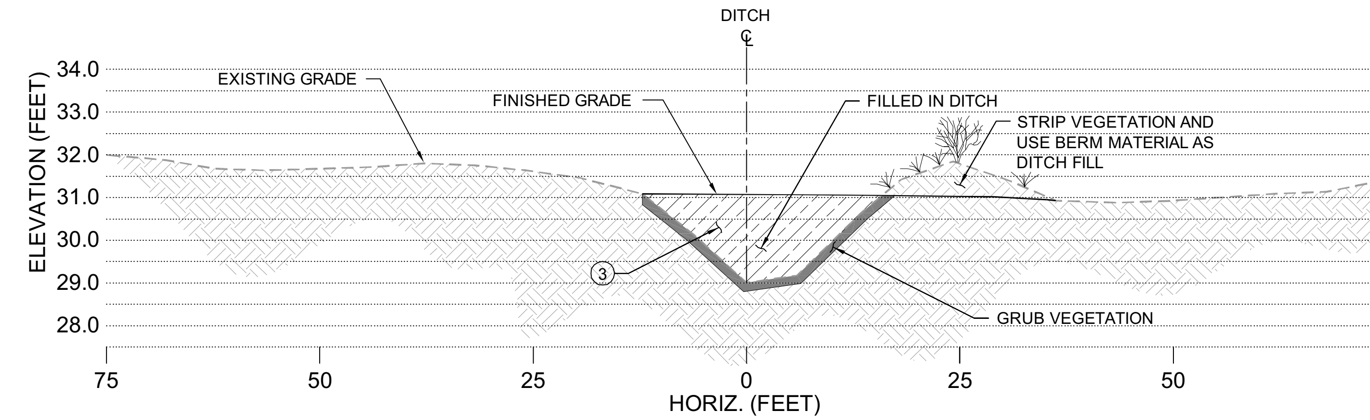



DITCH 5

SCALE: N.T.S.

E
-




DITCH 6

SCALE: N.T.S.

F
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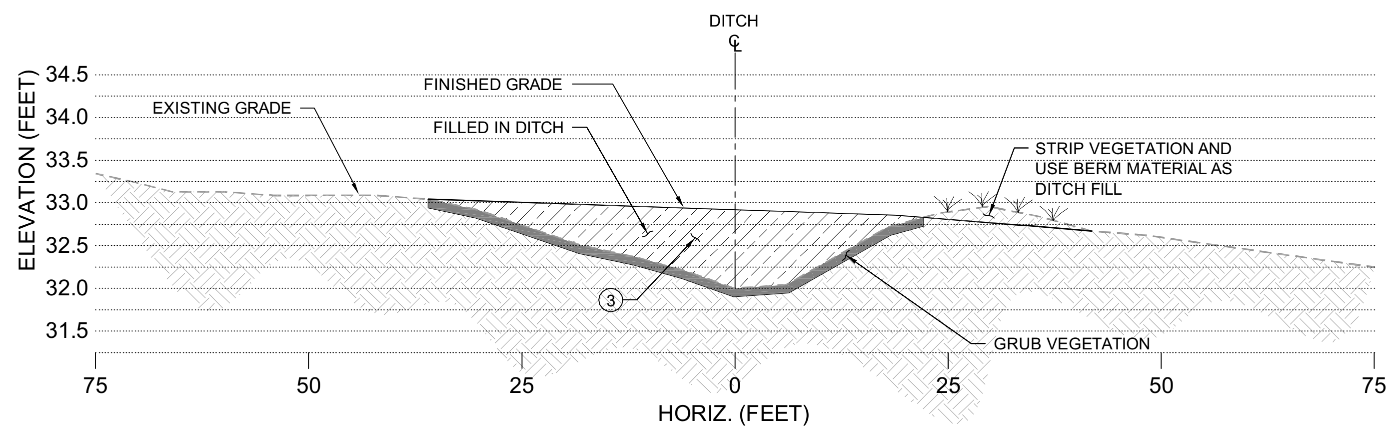
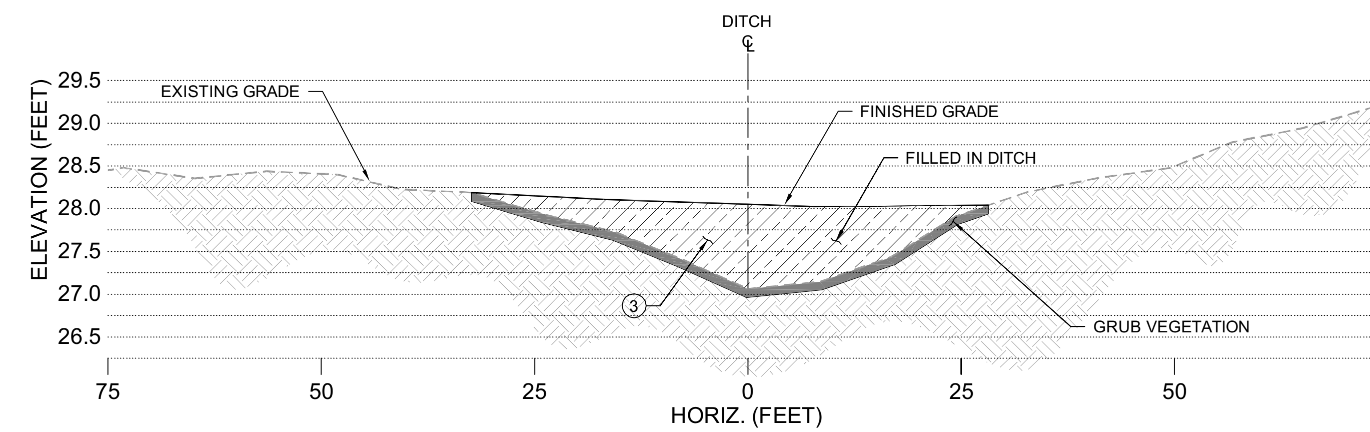



DITCH 7

SCALE: N.T.S.

G
-




DITCH 8

SCALE: N.T.S.

H
-

## CROSS SECTION NOTES:

1. FINISHED GRADE SHALL BE FREE OF DIPS, DEPRESSIONS, OR MOUNDS.
2. CUT AND FILL LINES ARE SHOWN GRAPHICALLY ONLY AND DO NOT REFLECT GRADING LIMITS REQUIRED TO MEET VOLUMES INDICATED IN DITCH TABLE.
3. SEE DITCH FILLING NOTES ON DRAWING G-3.
4. ELEVATIONS REFERENCE DISTANCE IN FEET ABOVE MEAN SEA LEVEL, VERTICAL DATUM NAVD 88.

## DITCH TABLE:

| DITCH ID # | DITCH LENGTH (FT) | DITCH WIDTH (FT) | DITCH DEPTH (FT) | DITCH VOLUME (CY) | BERM VOLUME (CY) | EXCESS FILL NEEDED (CY) |
|---|---|---|---|---|---|---|
| 1 | 3000 | 30 | 1 | 2267 | 1858 | 408 |
| 2 | 900 | 36 | 0.6 | 351 | 246 | 105 |
| 3 | 1400 | 18 | 0.6 | 272 | 252 | 20 |
| 4 | 1300 | 66 | 5 | 8716 | 0 | 8716 |
| 5 | 800 | 54.2 | 7.1 | 0 | 0 | 0 |
| 6 | 200 | 31.0 | 2 | 259 | 51 | 208 |
| 7 | 450 | 66.1 | 1.0 | 551 | 380 | 171 |
| 8 | 500 | 97.3 | 1.4 | 1261 | 0 | 1261 |
| TOTALS | 8550 | | | 13677 | 2787 | 10890 |



ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

# DRAFT DESIGN

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DRAWN: T. PRESCOTT
DESIGNED: -
SCALE:
DESIGNED: -
CHECKED: C. BARTON
RECOMMENDED: -
APPROVED: M. SPILLANE

SKAGIT ENVIRONMENTAL BANK
PHASE I

GRADING CROSS-SECTIONS

JUNE 2006

04-02822-003

C-5

SHEET NO: 9 OF 26

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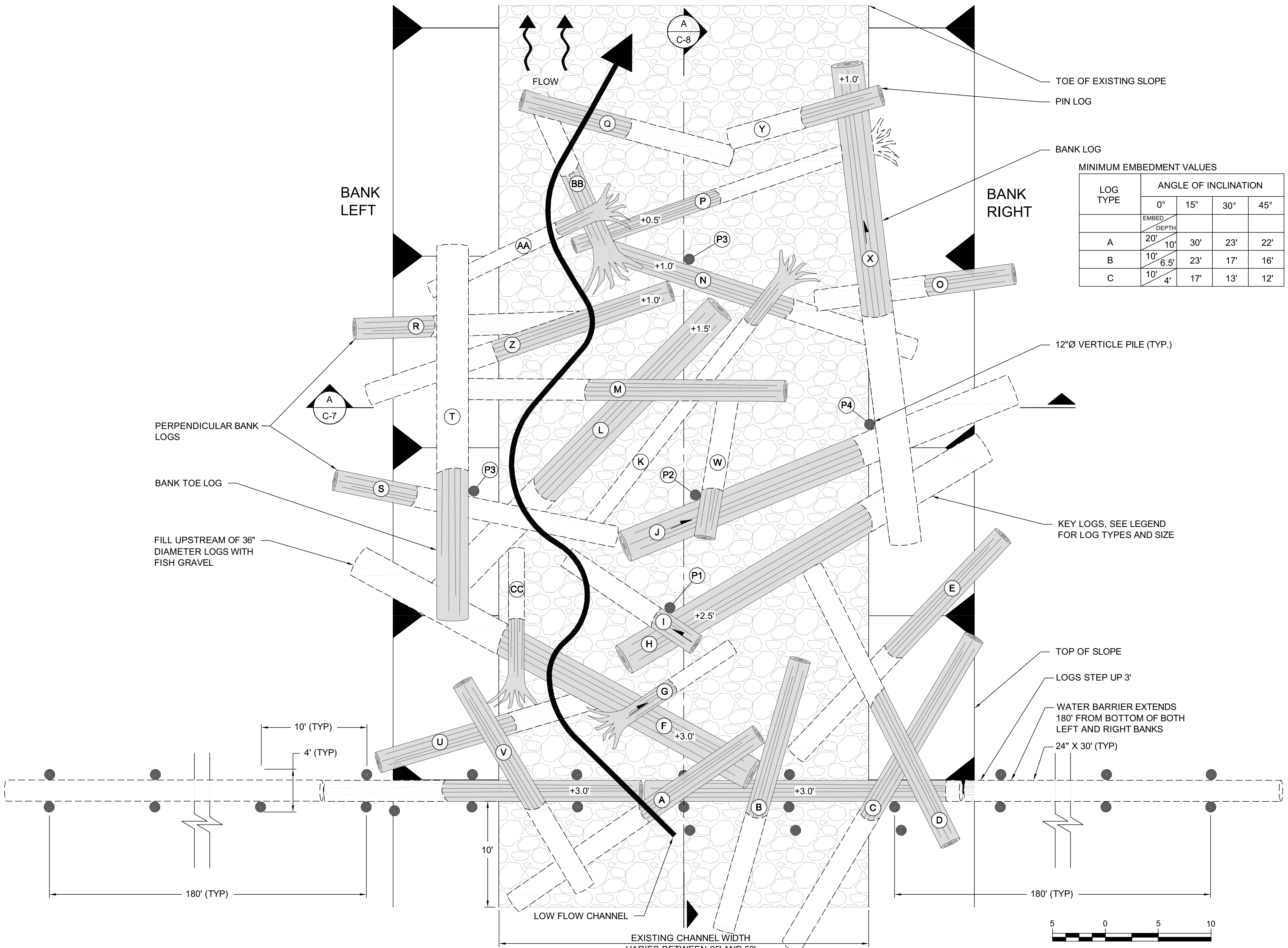


PLAN VIEW - TYPICAL ELJ STRUCTURE 1/-

SCALE: 1" = 5'

MINIMUM EMBEDMENT VALUES

| LOG TYPE | ANGLE OF INCLINATION 0° (EMBED / DEPTH) | 15° | 30° | 45° |
|---|---|---|---|---|
| A | 20' / 10' | 30' | 23' | 22' |
| B | 10' / 6.5' | 23' | 17' | 16' |
| C | 10' / 4' | 17' | 13' | 12' |

## CONSTRUCTION NOTES:

1. INSTALL WATER MANAGEMENT AND TESC BMPS. SEE SHEETS ESC-1 AND ESC-2.
2. SHAPE SLOPE TO ACHIEVE MAXIMUM 1.5 H:1 V SLOPE
3. CONSTRUCT WATER BARRIER WITHIN CHANNEL ONLY.
4. EXCAVATE 2' TRENCH FOR 36" DIAMETER LOGS
5. PLACE LAYER 1 LOGS. 36" DIAMETER LOGS TO REST IN KEYED TRENCH.
6. PLACE PERPENDICULAR AND BANK LOGS
7. PLACE BANK TOE LOGS.
8. PLACE PIN LOGS.
9. PLACE FISH GRAVEL.
10. ABANDON DIVERSION CHANNEL
11. CONSTRUCT FLOODPLAIN PORTION OF WATER BARRIER.

## NOTES:

1. PLAN VIEW OF TYPICAL CHANNEL SECTION.
2. TYPE B LOGS MAY HAVE ROOTWADS.
3. LOG EMBEDMENT LENGTH MINIMUM OF 6 FEET.

## LEGEND:

| | |
|---|---|
| 36"Ø BY 30' LONG | TYPE A |
| 24"Ø BY 30' LONG | TYPE B |
| 24"Ø BY 15' LONG | PIN LOG |
| 24"Ø BY 10' LONG (MIN) W/ ROOTWAD | |
| 18"Ø BY 30' LONG W/ ROOTWAD | TYPE C |
| | 12"Ø VERTICAL PILE |
| +3.0' | LOG SLOPE DOWN AND HEIGHT ABOVE EXISTING CHANNEL |
| EXPOSED PORTION | BURIED PORTION |
| | FISH GRAVEL |



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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| DESIGNED: - | SCALE: AS NOTED |
| DESIGNED: - | CHECKED: C. BARTON |
| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE I

ELJ - GRADE CONTROL STRUCTURE PLAN

JUNE 2006

04-02822-003

C-6

SHEET NO: 10 OF 26

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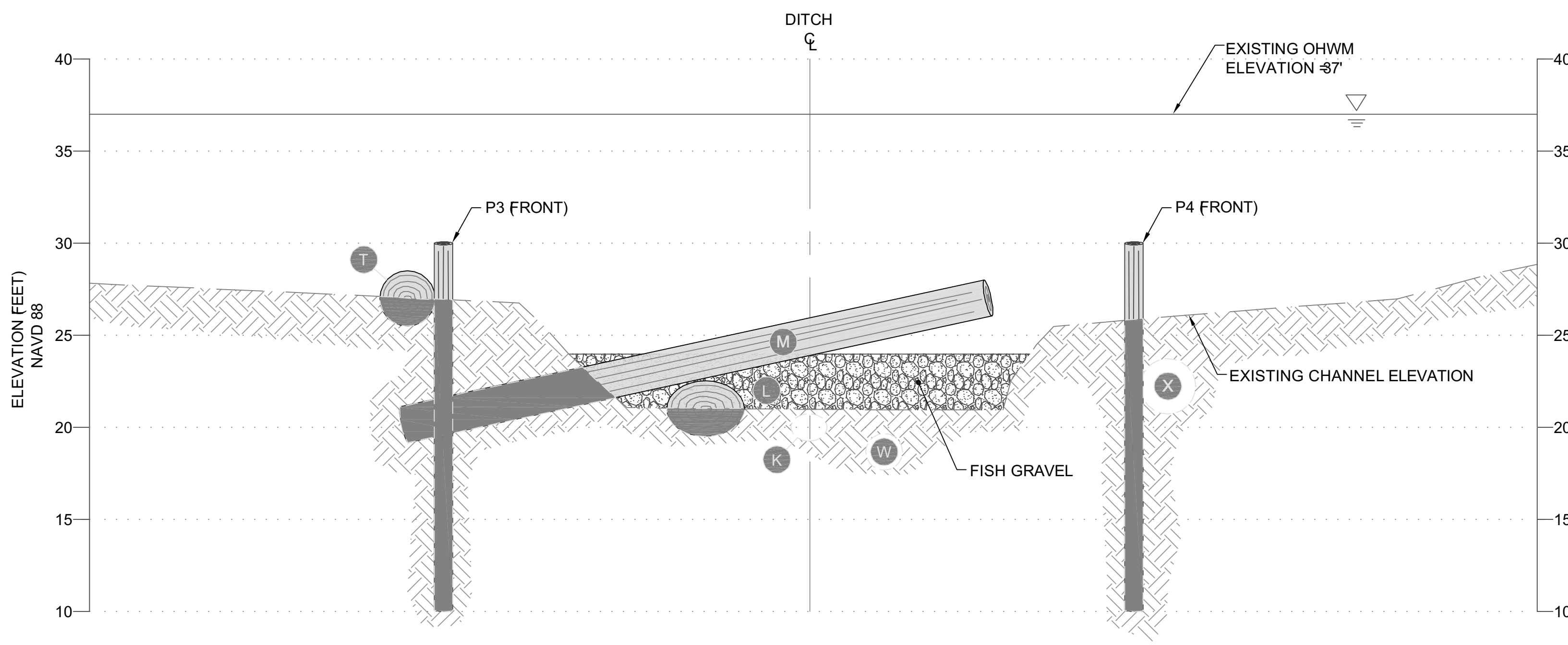


SECTION A / C-6

SCALE: 1" =5'

5 0 5 10

1"=5'



ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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SKAGIT ENVIRONMENTAL BANK
PHASE I

ELJ - GRADE CONTROL STRUCTURE SECTION

JUNE 2006

04-02822-003

C-7

SHEET NO: 11 OF 26

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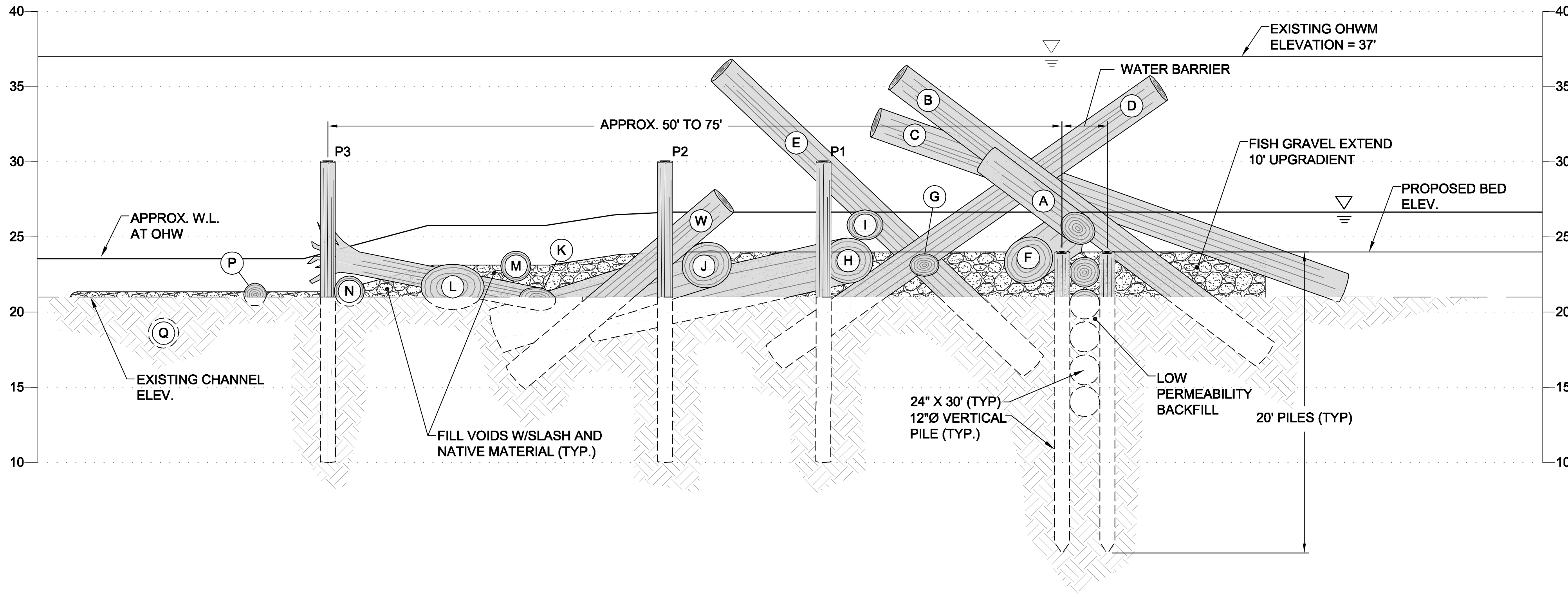
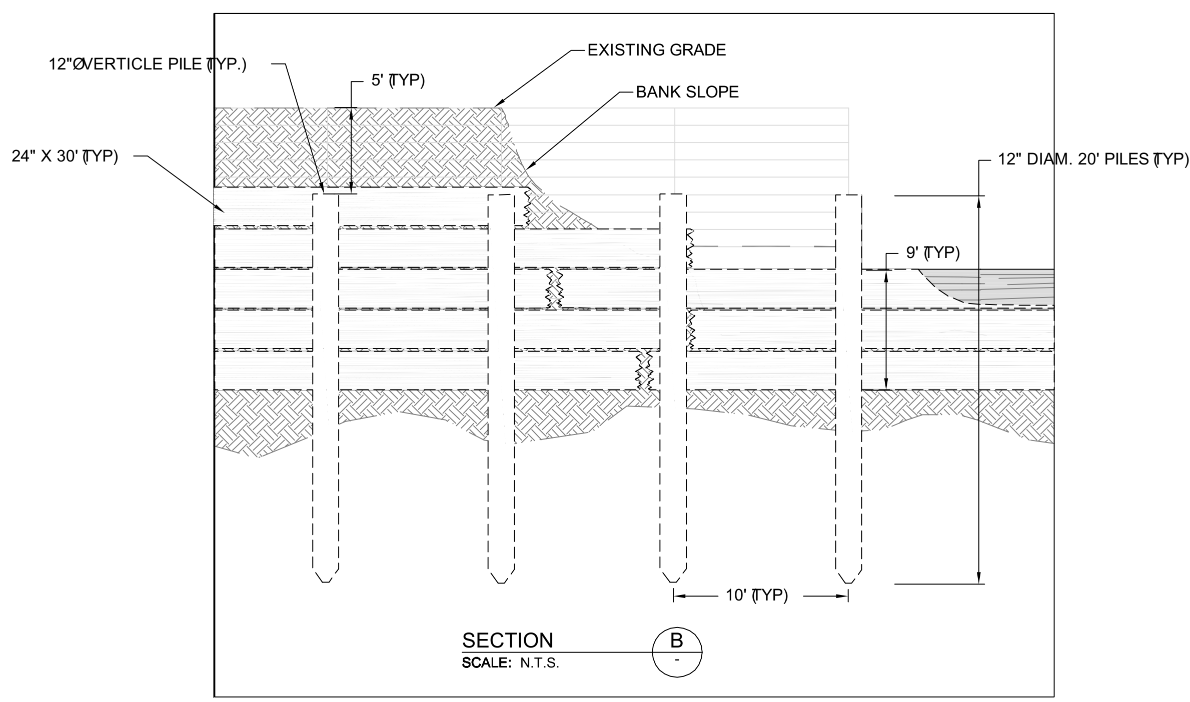



SECTION A / C-6
SCALE: 1" = 5'

5 0 5 10
1"=5'




SECTION B / -
SCALE: N.T.S.



ONE INCH
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| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE I

ELJ - GRADE CONTROL STRUCTURE
LONGITUDINAL CROSS-SECTION

JUNE 2006
04-02822-003
C-8
SHEET NO: 12 OF 26

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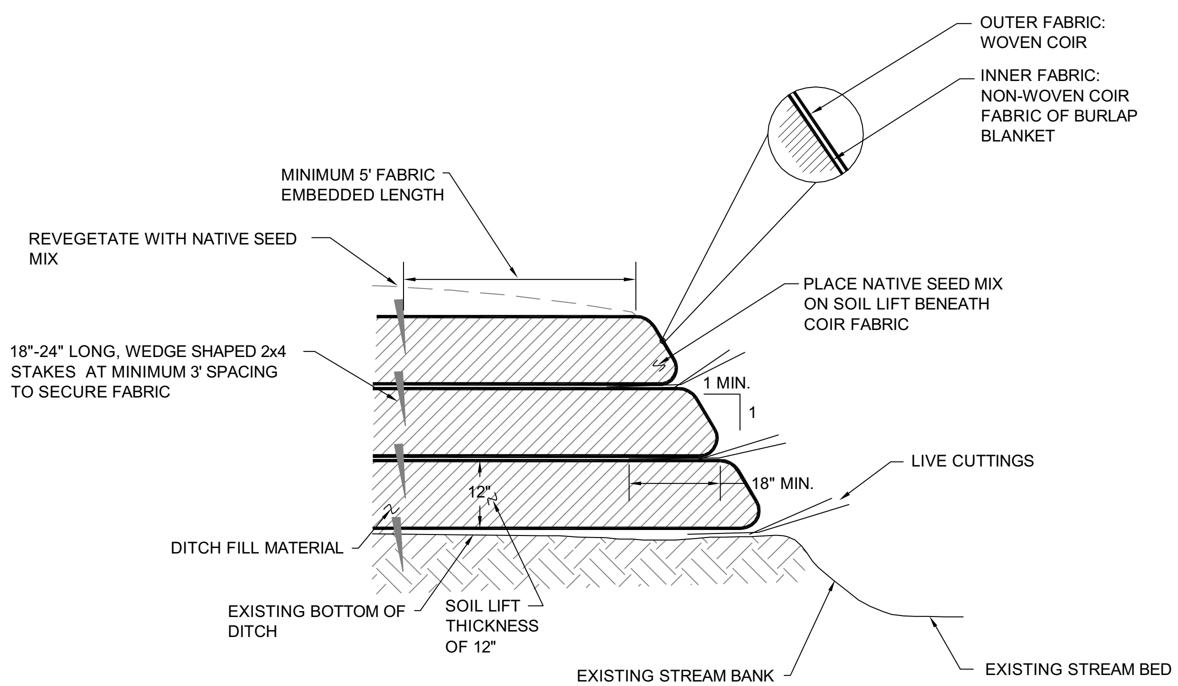


DITCH FILLING HEADCUT EROSION PREVENTION STRUCTURE PROFILE

SCALE: N.T.S.

1
C10



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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SKAGIT ENVIRONMENTAL BANK
PHASE I

GRADE CONTROL STRUCTURE
LONGITUDINAL CROSS-SECTION

JUNE 2006

04-02822-003

C-9

SHEET NO: 13 OF 26

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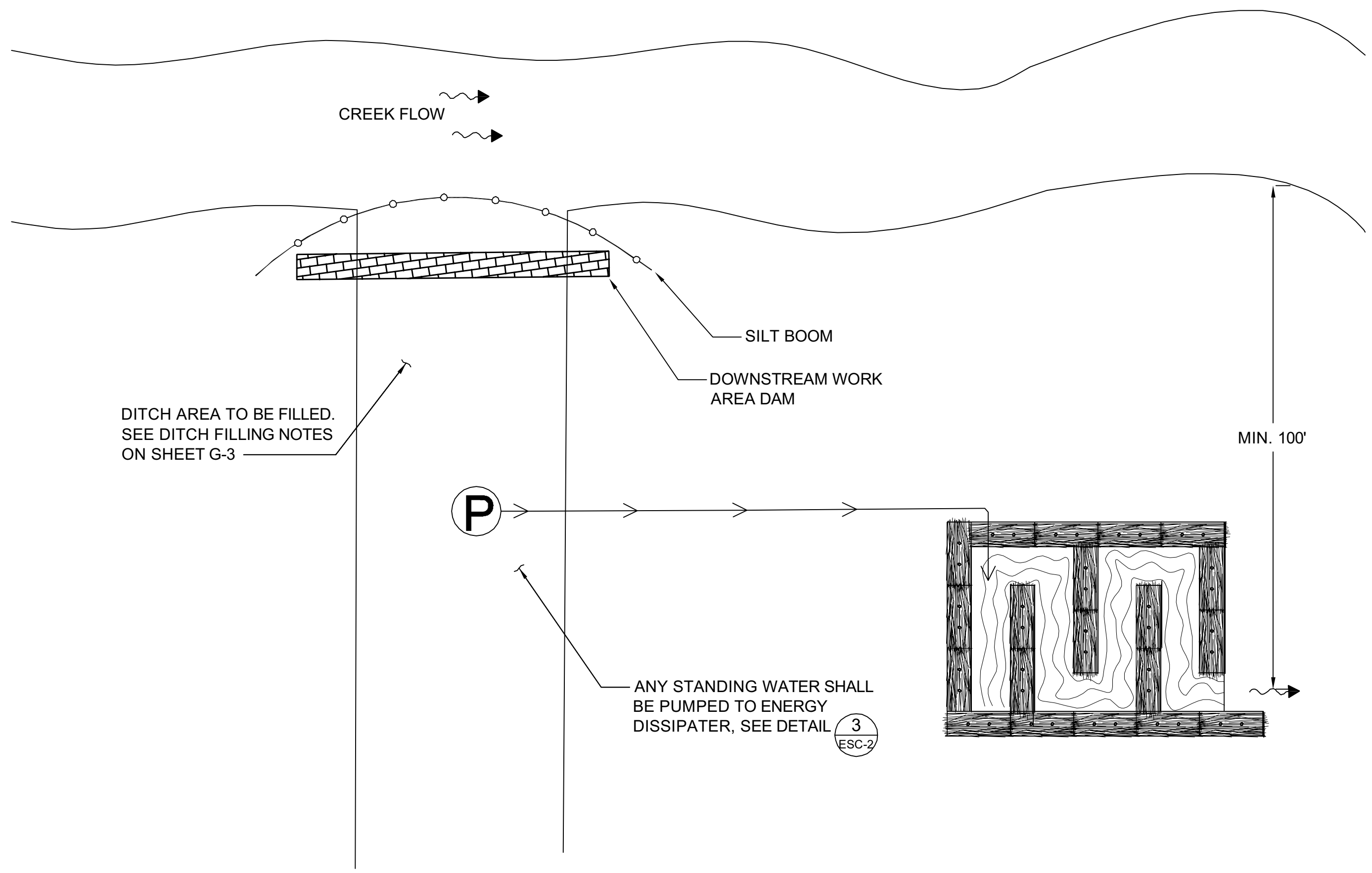
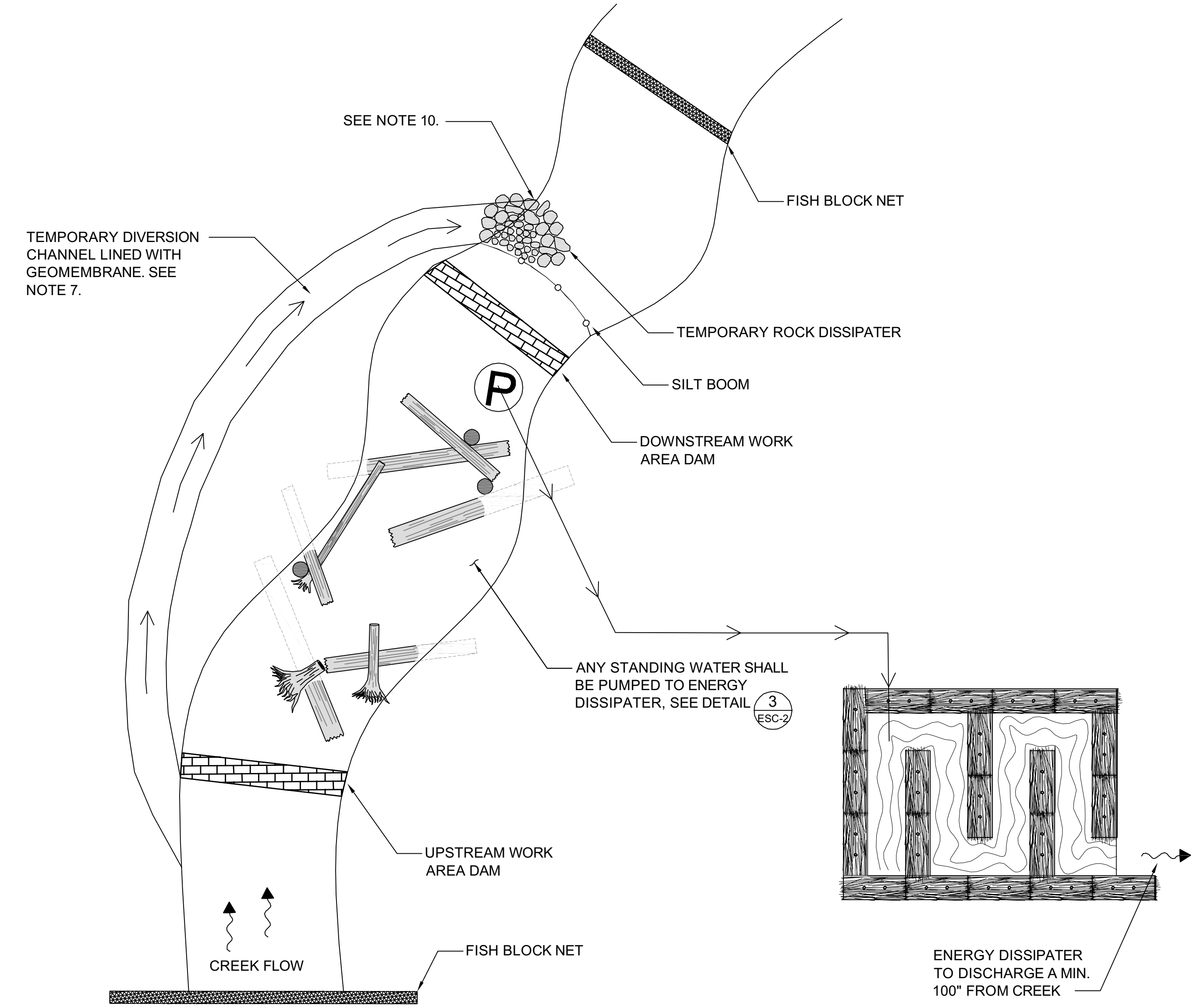



TYPICAL DITCH FILLING WATER MANAGEMENT DETAIL 1 ESC-1

SCALE: NTS




TYPICAL ELJ CONSTRUCTION WATER MANAGEMENT DETAIL 2 ESC-1

SCALE: NTS

## DITCH DETAIL NOTES:

1. EXCAVATIONS THAT HAVE POTENTIAL TO IMPACT THE WETTED CHANNEL SHALL BE ISOLATED FROM THE ACTIVE CHANNEL BY THE CONTRACTOR. ISOLATION MEANS SHALL CONSIST OF SILT BOOMS, SHEET PILE, BULK BAGS, BLADDER DAMS OR OTHERS AS NECESSARY TO PREVENT IMPACTS TO WATER QUALITY.
2. DEWATERING ACTIVITIES SHALL NOT IMPACT WATER QUALITY.
3. INSTALL TEMPORARY SILT BOOM TO ISOLATE DITCH OR WORK AREA AS SHOWN ON THE PLAN.
4. CONDUCT FISH REMOVAL (SEINING) IN PROPOSED WORK AREA PRIOR TO ANY EXCAVATION, GRADING OR CONSTRUCTION OF INSTREAM STRUCTURES.
5. PUMP SURFACE WATER FROM DITCHES TO UPLAND AREAS FOR INFILTRATION PRIOR TO STRIPPING AND FILLING.
6. CONTRACTOR SHALL DEWATER EXCAVATIONS AS NECESSARY FOR CONSTRUCTION AND INSPECTION.

## STREAM DETAIL NOTES:

1. EXCAVATIONS THAT HAVE POTENTIAL TO IMPACT THE WETTED CHANNEL SHALL BE ISOLATED FROM THE ACTIVE CHANNEL BY THE CONTRACTOR. ISOLATION MEANS SHALL CONSIST OF SILT BOOMS, SHEET PILE, BULK BAGS, BLADDER DAMS OR OTHERS AS NECESSARY TO PREVENT IMPACTS TO WATER QUALITY.
2. DEWATERING ACTIVITIES SHALL NOT IMPACT WATER QUALITY.
3. INSTALL TEMPORARY SILT BOOMS TO ISOLATE WORK AREA AS SHOWN ON THE PLAN.
4. CONDUCT FISH REMOVAL (SEINING) IN PROPOSED WORK AREA PRIOR TO ANY EXCAVATION, GRADING OR CONSTRUCTION OF INSTREAM STRUCTURES.
5. INSTALL BLOCK NETS TO ISOLATE WORK AREA.
6. CONTRACTOR SHALL DEWATER AS NECESSARY FOR CONSTRUCTION AND INSPECTION.
7. STREAM DIVERSION SHALL BE ACCOMPLISHED BY EITHER PUMPING OR BY TEMPORARY CHANNEL DIVERSION.
8. CONTRACTOR SHALL SUBMIT A WATER MANAGEMENT PLAN 14 DAYS PRIOR TO ANY INSTREAM ACTIVITY FOR APPROVAL BY ENGINEER.
9. TEMPORARY CHANNEL DIVERSION SHALL BE LINED WITH GEOMEMBRANE TO LIMIT EROSION. TEMPORARY CHANNEL SHALL BE BACKFILLED AND COMPACTED FOLLOWING CONSTRUCTION.
10. CONSTRUCT HEAD CUT EROSION PREVENTION STRUCTURE AT COMPLETION OF WATER DIVERSION.



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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| DESIGNED: - | CHECKED: C. BARTON |
| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE I

EROSION AND SEDIMENT CONTROL PLAN

JUNE 2006

04-02822-003

ESC-1

SHEET NO: 14 OF 26

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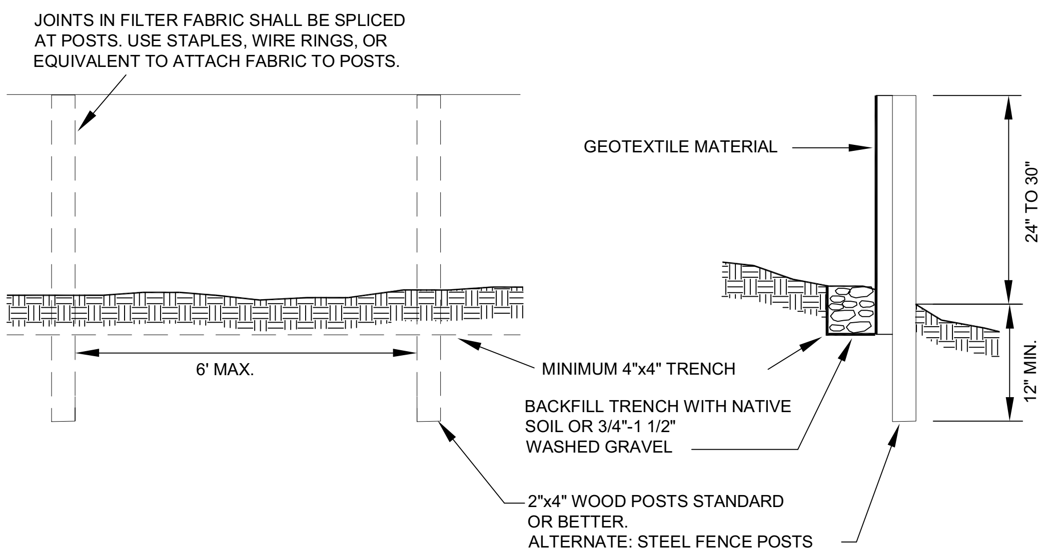
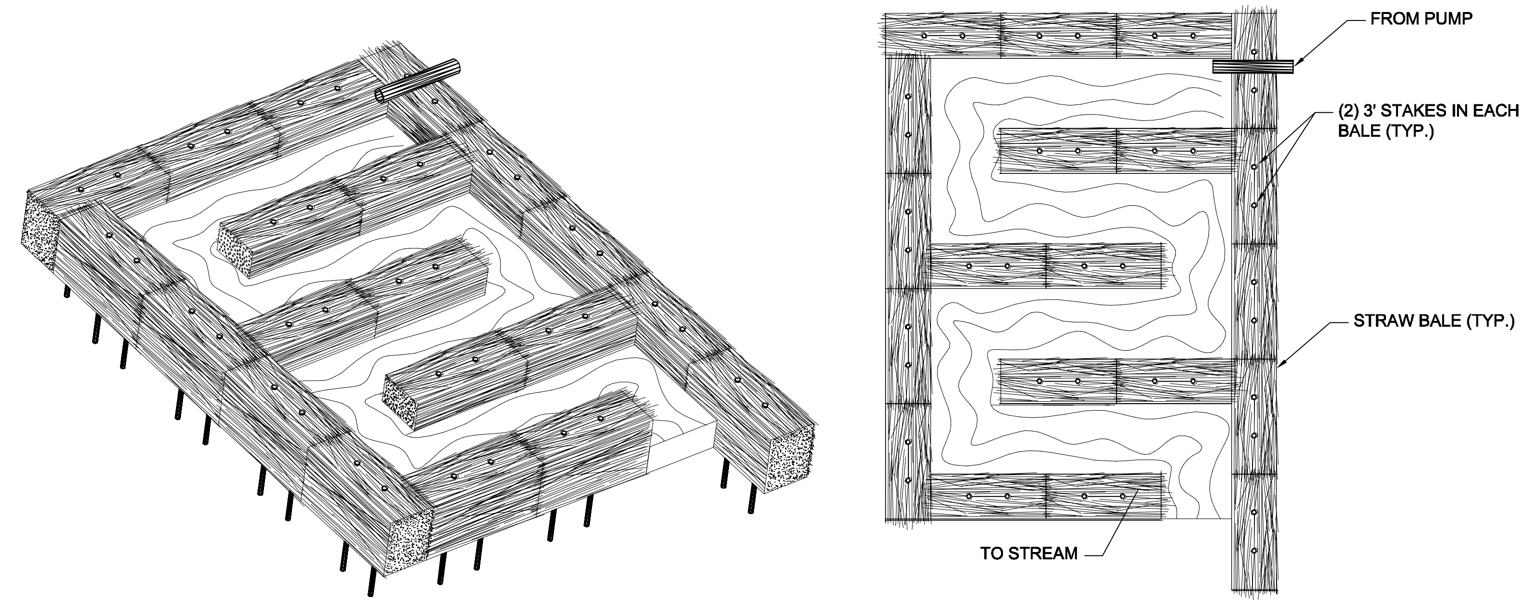



SILT FENCE ELEVATION DETAIL (1 / ESC-2)
SCALE: NTS

SILT FENCE STAKING DETAIL (2 / ESC-2)
SCALE: NTS




ENERGY DISSIPATOR DETAIL (3 / ESC-2)
SCALE: NTS

## EROSION AND SEDIMENT CONTROL NOTES:

1. APPROVAL OF THE CONTRACTOR'S TEMPORARY WATER AND SEDIMENT CONTROL PLAN DOES NOT CONSTITUTE AN APPROVAL OF PERMANENT ROAD OR DRAINAGE DESIGN (E.G., SIZE AND LOCATION OF ROADS, PIPES, RESTRICTORS, CHANNELS, RETENTION FACILITIES, UTILITIES, ETC.).
2. THE IMPLEMENTATION OF EROSION AND SEDIMENT CONTROL (ESC) PLANS AND THE CONSTRUCTION, MAINTENANCE, REPLACEMENT, AND UPGRADING OF ESC FACILITIES IS THE RESPONSIBILITY OF THE CONTRACTOR UNTIL ALL CONSTRUCTION IS APPROVED.
3. THE ESC FACILITIES SHOWN ON THIS PLAN MUST BE CONSTRUCTED PRIOR TO OR IN CONJUNCTION WITH ALL CLEARING AND GRADING SO AS TO ENSURE THAT THE TRANSPORT OF SEDIMENT TO SURFACE WATERS, DRAINAGE SYSTEMS, AND ADJACENT PROPERTIES IS MINIMIZED.
4. THE ESC FACILITIES SHOWN ON THIS PLAN ARE THE MINIMUM REQUIREMENTS FOR ANTICIPATED SITE CONDITIONS. DURING THE CONSTRUCTION PERIOD, THESE ESC FACILITIES SHALL BE UPGRADED AS NEEDED FOR UNEXPECTED STORM EVENTS AND MODIFIED TO ACCOUNT FOR CHANGING SITE CONDITIONS (E.G., ADDITIONAL SUMP PUMPS, RELOCATION OF DITCHES AND SILT FENCES, ETC.).
5. THE ESC FACILITIES SHALL BE INSPECTED DAILY BY THE CONTRACTOR'S ESC SUPERVISOR AND MAINTAINED TO ENSURE CONTINUED PROPER FUNCTIONING. WRITTEN RECORDS SHALL BE KEPT OF WEEKLY REVIEWS OF THE ESC FACILITIES.
6. ANY AREAS OF EXPOSED SOILS, INCLUDING ROADWAY EMBANKMENTS, THAT WILL NOT BE DISTURBED FOR SEVEN DAYS SHALL BE IMMEDIATELY STABILIZED WITH THE APPROVED ESC METHODS (E.G., SEEDING, MULCHING, PLASTIC COVERING, ETC.).
7. ANY AREA NEEDING ESC MEASURES THAT DO NOT REQUIRE IMMEDIATE ATTENTION SHALL BE ADDRESSED WITHIN SEVEN (7) DAYS.
8. THE ESC FACILITIES ON INACTIVE SITES SHALL BE INSPECTED AND MAINTAINED OR WITHIN TWENTY FOUR (24) HOURS FOLLOWING A STORM EVENT.
9. STABILIZED CONSTRUCTION ENTRANCES AND ROADS SHALL BE INSTALLED AT THE BEGINNING OF CONSTRUCTION AND MAINTAINED FOR THE DURATION OF THE PROJECT. ADDITIONAL MEASURES, SUCH AS WASH PADS, MAY BE REQUIRED TO ENSURE THAT ALL PAVED AREAS ARE KEPT CLEAN FOR THE DURATION OF THE PROJECT.
10. WHERE STRAW MULCH FOR TEMPORARY EROSION CONTROL IS REQUIRED, IT SHALL BE APPLIED AT A MINIMUM THICKNESS OF 2 TO 3 INCHES.

## NOTES:

1. THE FILTER FABRIC (CONSTRUCTION GEOTEXTILE FOR TEMPORARY SILT FENCE) SHALL BE PURCHASED IN A CONTINUOUS ROLL, 5FT WIDE, CUT TO THE LENGTH OF THE BARRIER TO AVOID USE OF JOINTS. WHEN JOINTS ARE NECESSARY, THE FILTER FABRIC SHALL BE SPLICED TOGETHER ONLY AT A SUPPORT POST, WITH A MINIMUM 6 INCH OVERLAP, AND SECURELY FASTENED TO THE POST.
2. THE FENCE POSTS SHALL BE SPACED A MAXIMUM OF 6 FEET APART AND DRIVEN SECURELY INTO THE GROUND A MINIMUM OF 12 INCHES.
3. A TRENCH SHALL BE EXCAVATED A MINIMUM OF 4 INCHES WIDE BY 4 INCHES DEEP, UPSLOPE AND ADJACENT TO THE POST TO ALLOW THE FILTER FABRIC TO BE BURIED.
4. THE FILTER FABRIC SHALL BE STAPLED OR WIRED TO THE POSTS, AND 18 INCHES OF THE FABRIC SHALL BE EXTENDED INTO THE TRENCH. THE FABRIC SHALL NOT EXTEND MORE THAN 30 INCHES ABOVE THE ORIGINAL GROUND SURFACE. FILTER FABRIC SHALL NOT BE STAPLED TO TREES.
5. THE TRENCH SHALL BE BACKFILLED WITH NATIVE SOIL OR WITH 3/4"-1 1/2" WASHED GRAVEL.
6. SILT FENCES SHALL BE REMOVED AT DIRECTION OF ENGINEER, BUT NOT BEFORE THE UPSLOPE AREA HAS BEEN PERMENANTLY STABILIZED.
7. SILT FENCES SHALL BE INSPECTED IMMEDIATELY AFTER EACH RAINFALL EVENT AND AT LEAST DAILY DURING PROLONGED RAINFALL. ANY REQUIRED REPAIRS SHALL BE MADE IMMEDIATELY.
8. SILT FENCE PERFORMANCE SHALL BE EVALUATED AND SILT FENCE LOCATIONS SHALL BE EVALUATED AND ADJUSTED AS DIRECTED OR APPROVED BY THE ENGINEER AND THE PERMITTING AUTHORITY.
9. SILT FENCE SHALL BE INSTALLED AS SHOWN ON DRAWINGS.
10. ANY DEVIATION OR CHANGE TO SILT FENCE DETAILS MUST BE APPROVED BY AN INSPECTOR FOR KING COUNTY DDES.
11. THE CONTRACTOR SHALL MAINTAIN A COPY OF THE MANUFACTURER'S SPECIFICATIONS FOR FILTER FABRIC ON SITE.
12. MAINTENANCE STANDARDS:
    A. ANY DAMAGE SHALL BE REPAIRED IMMEDIATELY.
    B. IF CONCENTRATED FLOWS ARE EVIDENT UPHILL OF THE SILT FENCE, THEY MUST BE INTERCEPTED AND CONVEYED TO A SEDIMENT TRAP OR POND, OR OTHERWISE DIVERTED TO A LOCATION THAT DOES NOT RESULT IN TURBID DISCHARGES TO SURFACE WATERS.
    C. THE UPHILL SIDE OF THE SILT FENCE SHALL BE CHECKED FOR SIGNS OF THE SILT FENCE CLOGGING, ACTING AS A BARRIER TO FLOW, AND CAUSING CHANNELIZATION OF FLOWS PARALLEL TO THE FENCE. IF SUCH CHANNELIZATION OCCURS, THE CONTRACTOR SHALL REPLACE THE FENCE OR REMOVE THE TRAPPED SEDIMENT.
    D. SEDIMENT SHALL BE REMOVED AND PROPERLY DISPOSED OF WHEN THE SEDIMENT IS 6 INCHES HIGH.
    E. IF THE FILTER FABRIC HAS DETERIORATED DUE TO ULTRAVIOLET BREAKDOWN, IT SHALL BE REPLACED.



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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| DESIGNED: - | SCALE: AS NOTED |
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| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE I

EROSION AND SEDIMENT CONTROL DETAILS

JUNE 2006
04-02822-003
ESC-2
SHEET NO: 15 OF 26

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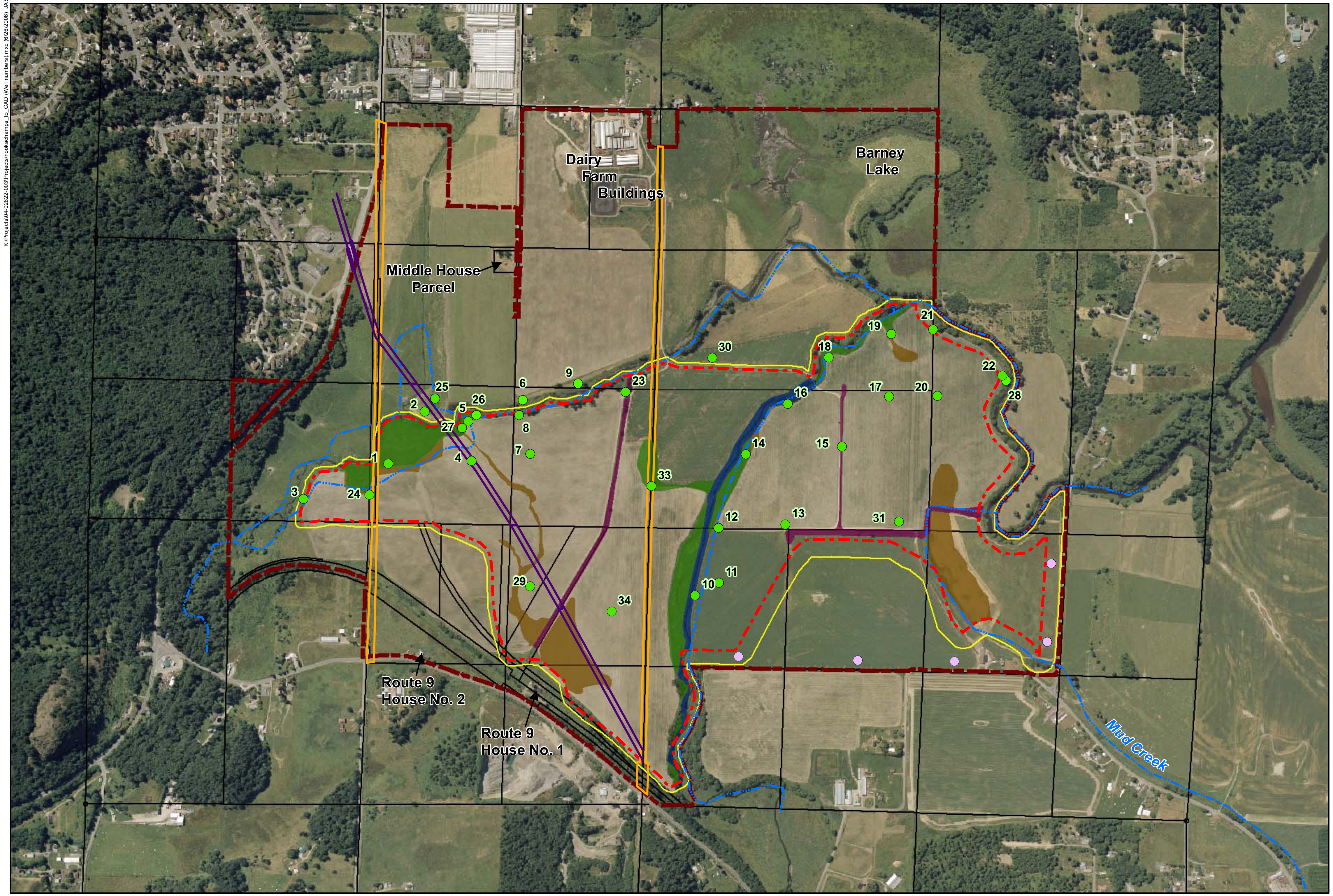


0 450 900 1,800 ft

1 in = 1000 ft

N

**Legend :**

- Well location and number
- Proposed well location
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine



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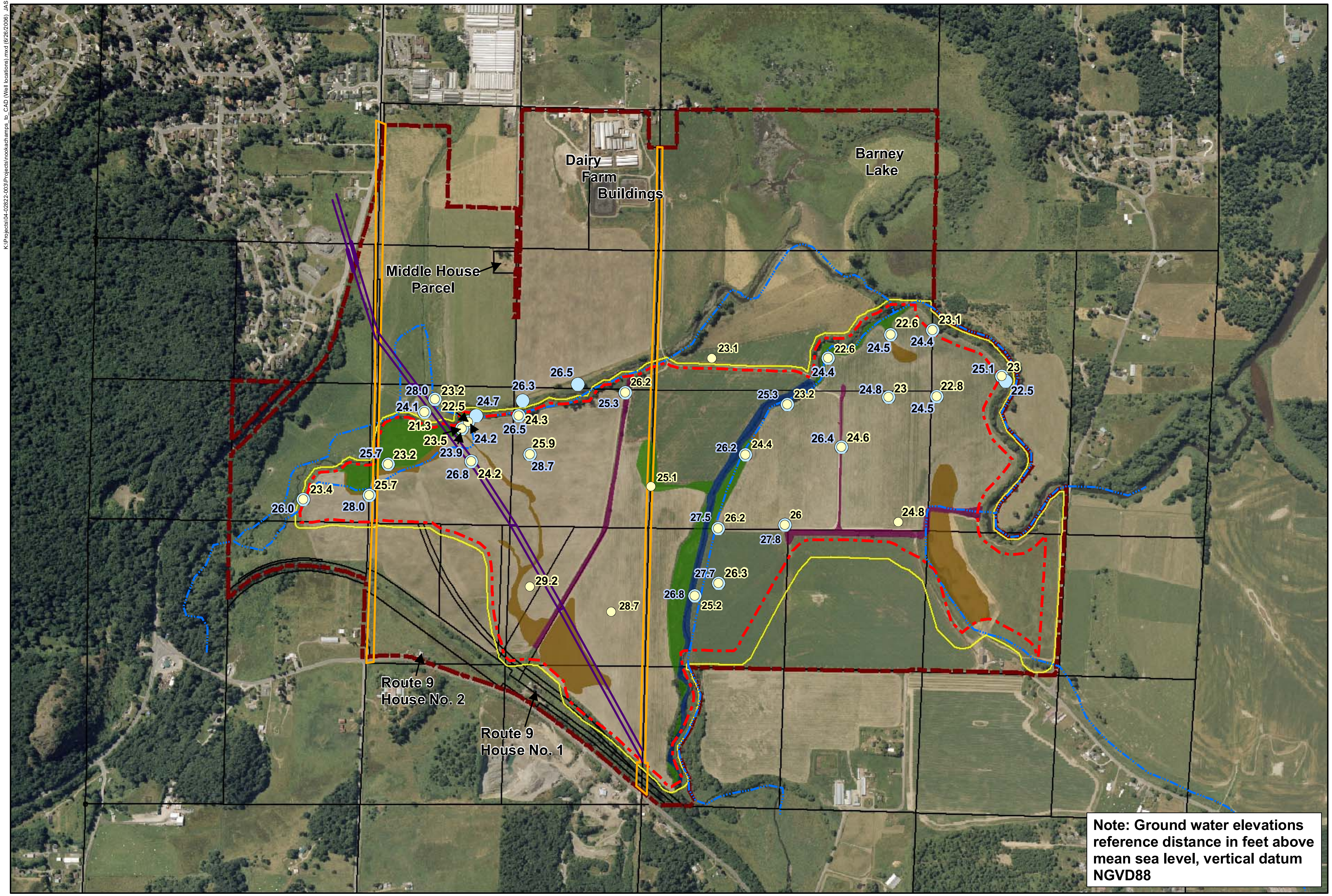
DESIGNED:
DRAWN:
DESIGNED:
CHECKED: C. BARTON
DESIGNED:
APPROVED: M. SPILLANE

# SKAGIT ENVIRONMENTAL BANK

## WELL LOCATIONS (INDICATING WELL NUMBER)

DATE: JUNE 2006
PROJECT NO: 04-02822-003
DRAWING NO: R-1
SHEET NO: 16 of 26




0 450 900 1,800 ft

1 in = 1000 ft

N

## Legend :

- 23.5 Ground water elevations - second quarter 2005 (ft)
- 23.5 Ground water elevations - third quarter 2005 (ft)
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine



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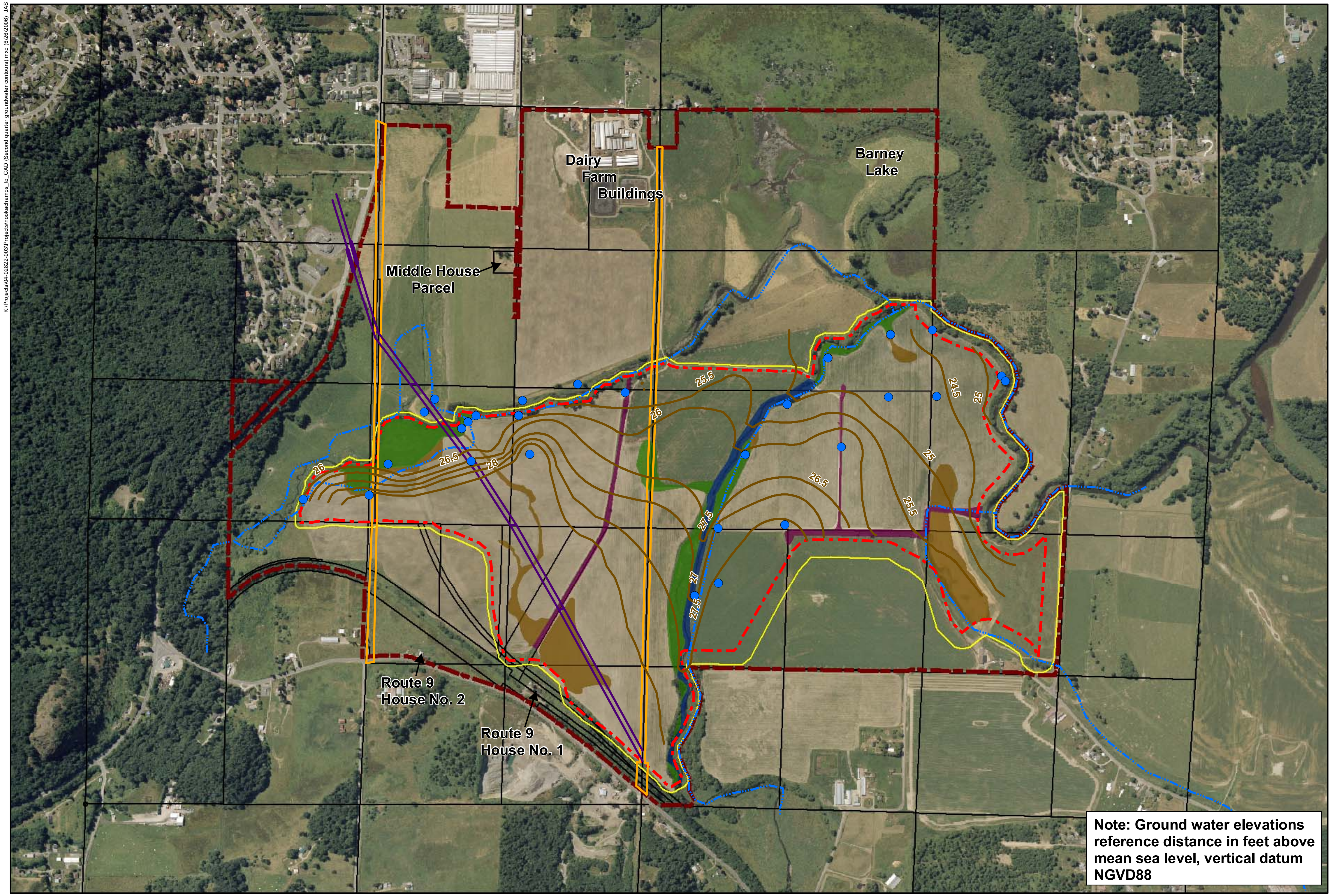
DRAWN: J. SCHMIDT
DESIGNED:
DRAWN:
DESIGNED:
CHECKED: C. BARTON
DESIGNED:
APPROVED: M. SPILLANE

# SKAGIT ENVIRONMENTAL BANK

## WELL ELEVATIONS (SECOND AND THIRD QUARTER 2005)

DATE: JUNE 2006
PROJECT NO: 04-02822-003
DRAWING NO: R-2
SHEET NO: 17 of 26




**Legend :**

- Well location
- 27.5 Second quarter 2005 ground water elevation contour (0.5 foot interval)
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine



| No. | REVISION | BY | APPD | DATE |
|---|---|---|---|---|
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| 1 | REVISION NO.1 | MS | | 05/06 |

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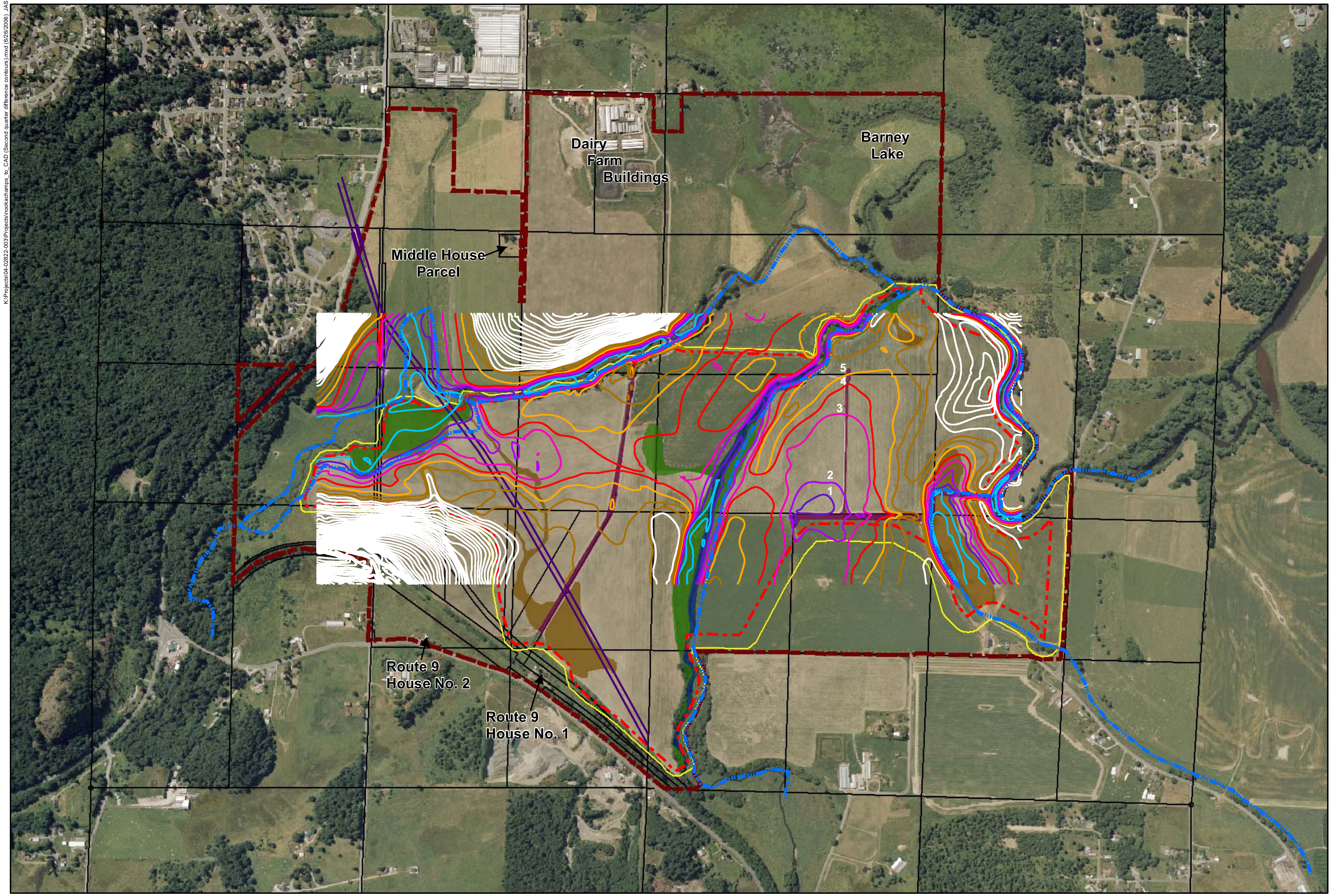
APPROVED: M. SPILLANE

# SKAGIT ENVIRONMENTAL BANK

## GROUND WATER CONTOURS SECOND QUARTER 2005

DATE: JUNE 2006
PROJECT NO: 04-02822-003
DRAWING NO: R-3
SHEET NO: 18 of 26




0 500 1,000 2,000 ft

1 in = 1000 ft

N

**Legend :**

**Depth to ground water from surface (in feet)**

- -1 - 0
- 0 - 1
- 1 - 2
- 2 - 3
- 3 - 4
- 4 - 5
- 5 - 6
- > 6
- Stream
- Waterline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary

**Existing wetlands**

- Palustrine: persistent
- Palustrine: non-persistent and plowed
- Palustrine: ditch
- Riverine



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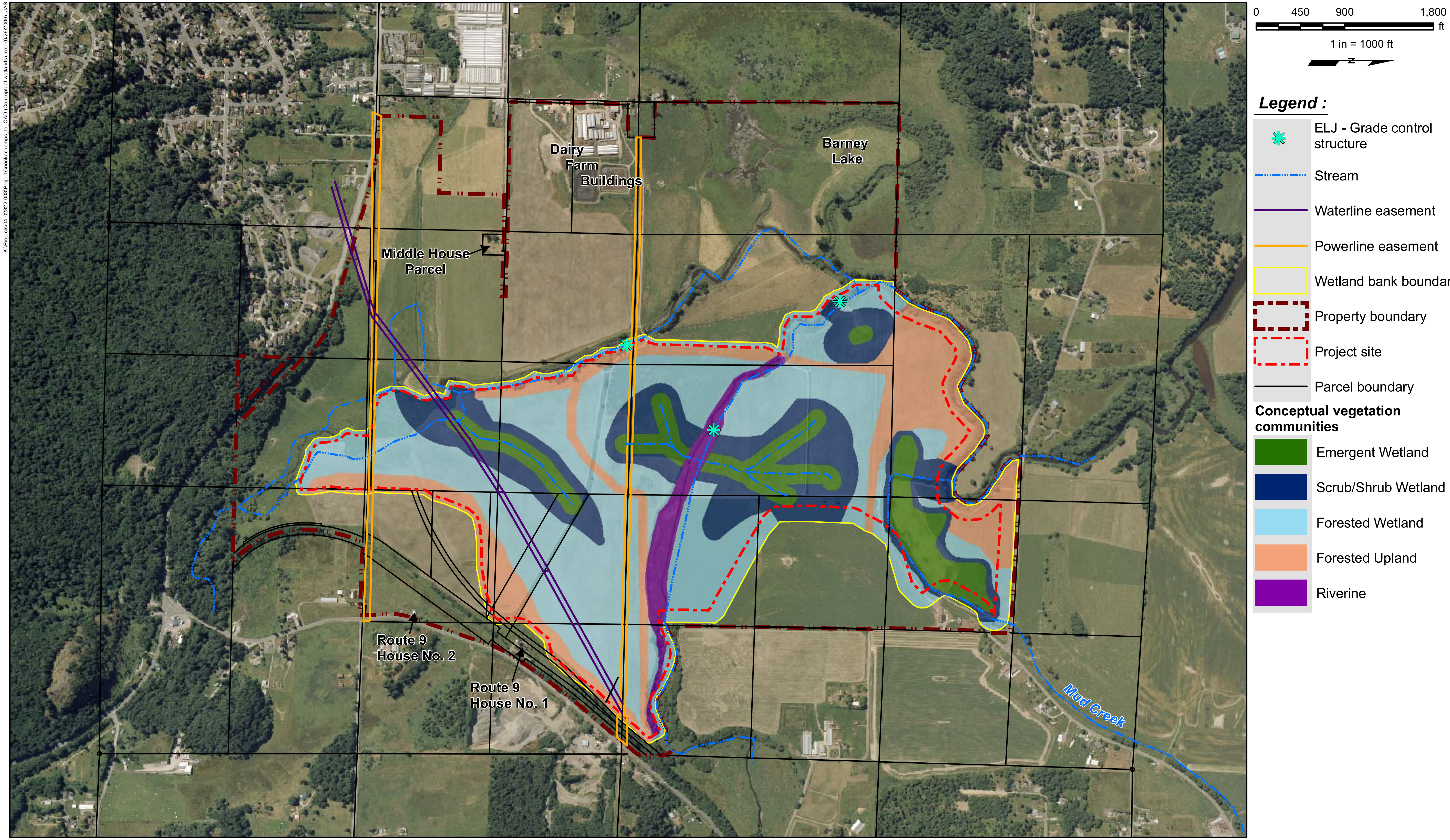
# SKAGIT ENVIRONMENTAL BANK

## DIFFERENCE BETWEEN GROUND SURFACE AND GROUND WATER ELEVATIONS (SECOND QUARTER 2005)

| | |
|---|---|
| DATE: | JUNE 2006 |
| PROJECT NO: | 04-02822-003 |
| DRAWING NO: | R-4 |
| SHEET NO: | 19 of 26 |

K:\Projects\04-02822-003\Projects\nookachamps_to_CAD (Conceptual wetlands).mxd (6/26/2006) JAS



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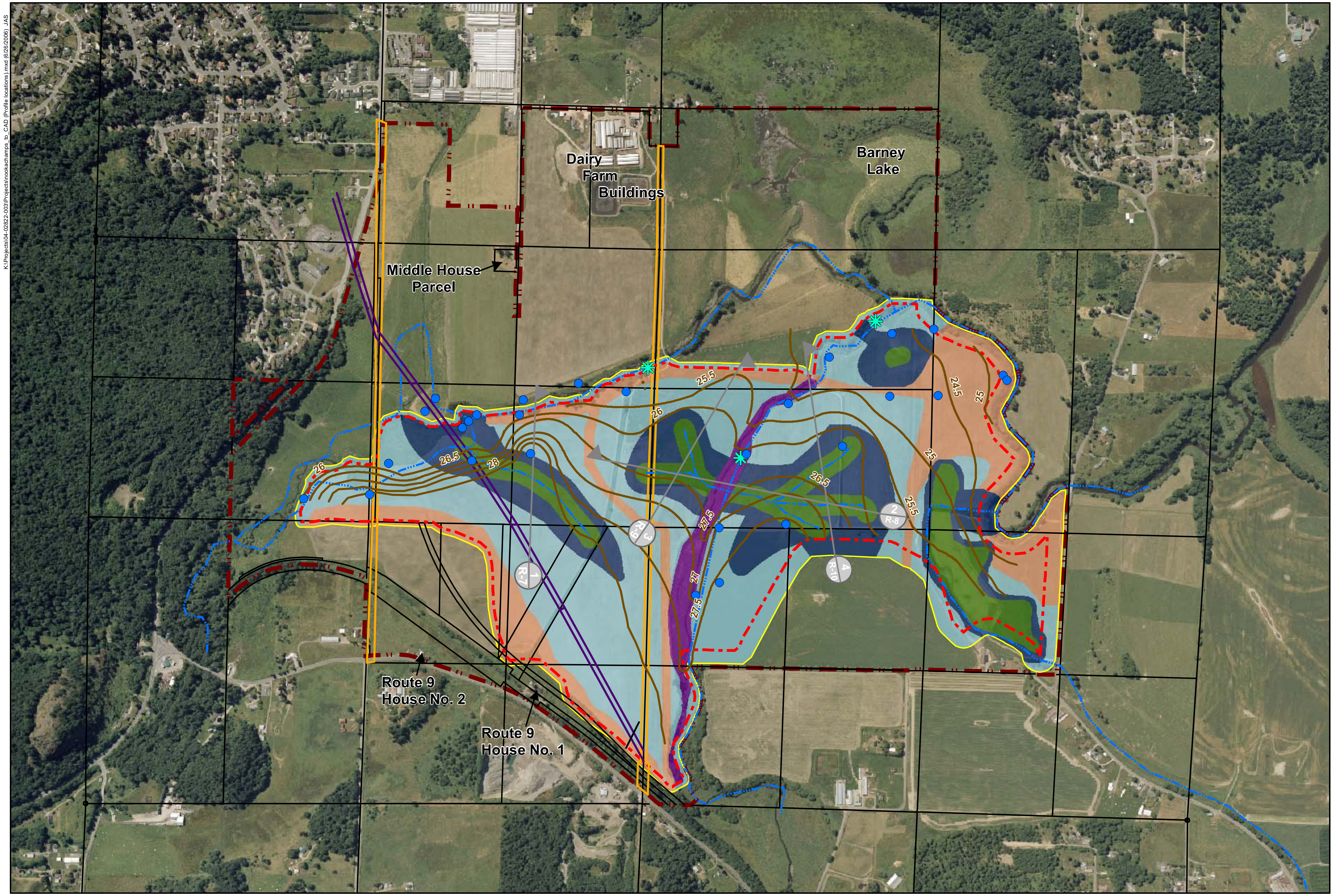
| DESIGNED: | DRAWN: |
| DESIGNED: | CHECKED: C. BARTON |
| DESIGNED: | APPROVED: M. SPILLANE |

# SKAGIT ENVIRONMENTAL BANK

## CONCEPTUAL PHASE II VEGETATION COMMUNITIES

| | |
|---|---|
| DATE: | JUNE 2006 |
| PROJECT NO: | 04-02822-003 |
| DRAWING NO: | R-5 |
| SHEET NO: | 20 of 26 |




0 450 900 1,800 ft

1 in = 1000 ft

N

### Legend :

- ELJ - Grade control structure
- Stream
- Waterline easement
- Powerline easement
- Wetland bank boundary
- Property boundary
- Project site
- Parcel boundary
- Well location
- Second quarter groundwater contours
- Profile location

**Conceptual vegetation communities**

- Emergent Wetland
- Scrub/Shrub Wetland
- Forested Wetland
- Forested Upland
- Riverine



| No. | REVISION | BY | APPD | DATE |
|---|---|---|---|---|
| 2 | REVISION NO.2 | MS | | 06/06 |
| 1 | REVISION NO.1 | MS | | 05/06 |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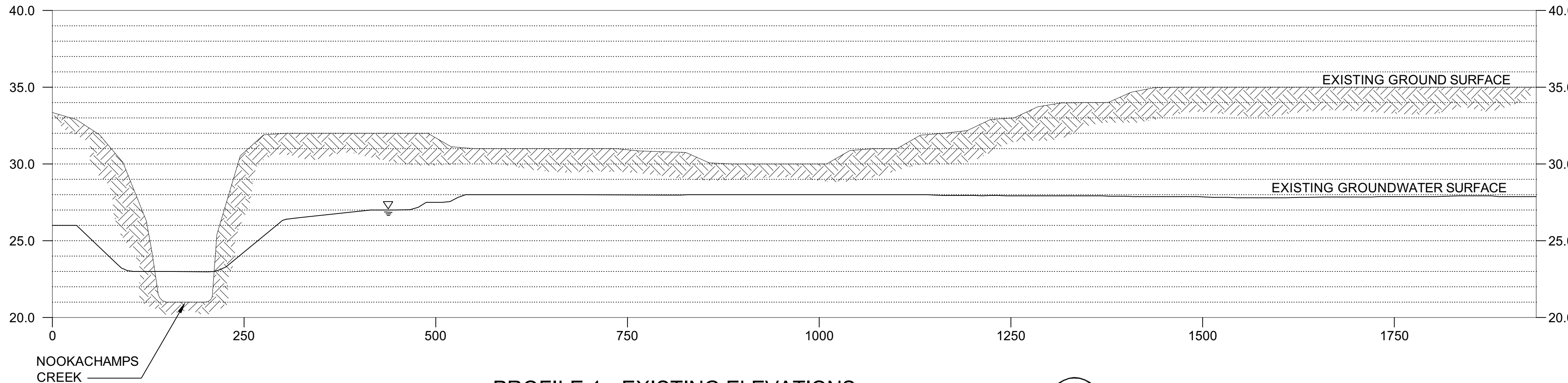
APPROVED: M. SPILLANE

SKAGIT ENVIRONMENTAL BANK

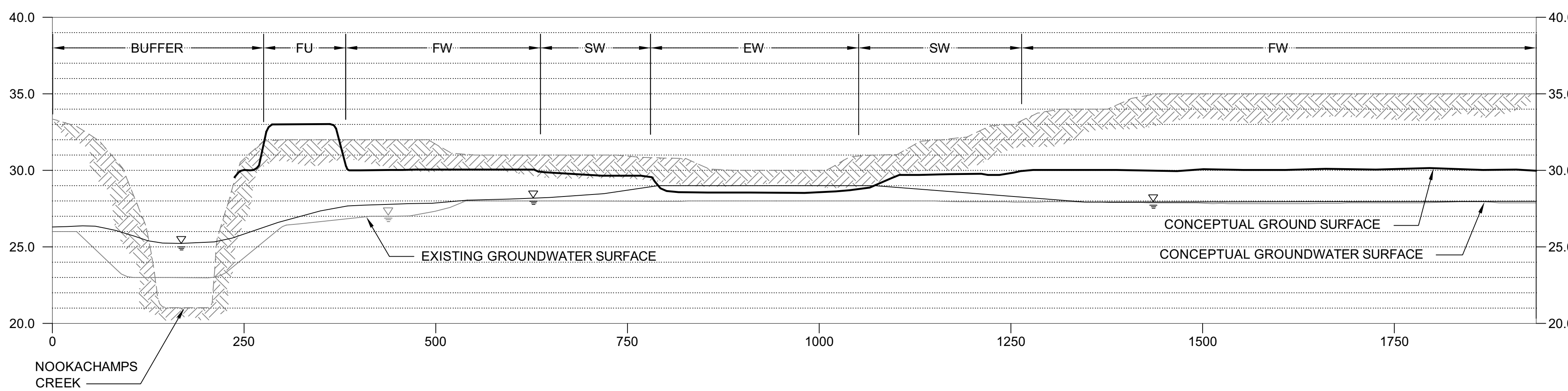
**PHASE II**
**PROFILE SECTION LOCATIONS**

DATE: JUNE 2006
PROJECT NO: 04-02822-003
DRAWING NO: R-6
SHEET NO: 21 of 26



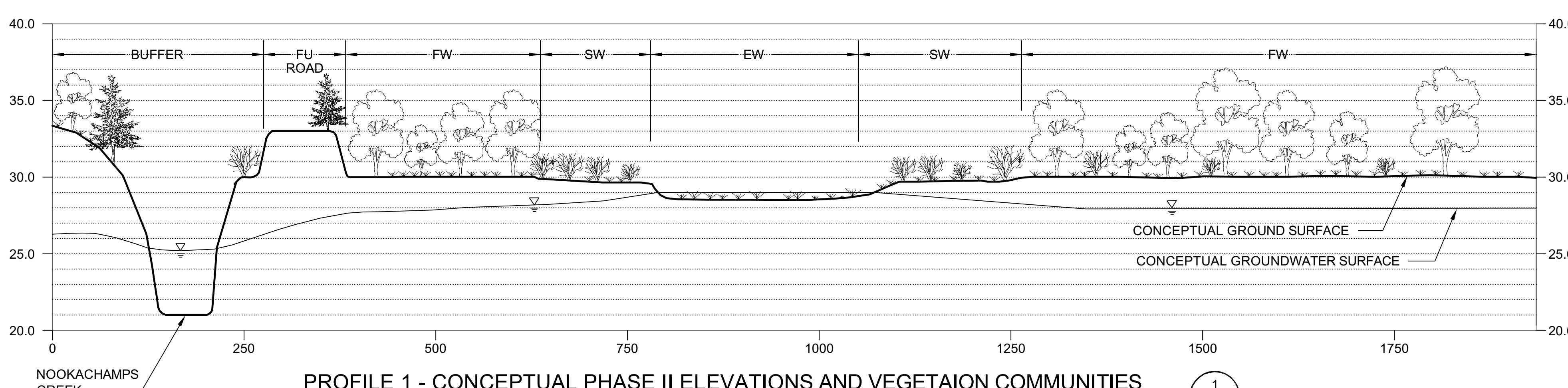

PROFILE 1 - EXISTING ELEVATIONS (1 / R-6)

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




PROFILE 1 - CONCEPTUAL PHASE II ELEVATIONS (1 / R-6)

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




PROFILE 1 - CONCEPTUAL PHASE II ELEVATIONS AND VEGETAION COMMUNITIES (1 / R-6)

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'
VEGETATION: = N.T.S.

## CONCEPTUAL VEGETATION LEGEND:

EW = EMERGENT WETLAND

SW = SCRUB/SHRUB WETLAND

FW = FORESTED WETLAND

FU = FORESTED UPLAND

## NOTE:

1. GROUNDWATER SURFACE ELEVATIONS ARE BASED ON 2005 SECOND QUARTERGROUNDWATER ELEVATIONS (APRIL, MAY, AND JUNE.).
2. ELEVATIONS REFERENCE DISTANCE IN FEET ABOVE MEAN SEA LEVEL, VERTICAL DATUM NAVD 88.
3. THE CONCEPTUAL WATER LEVELS ARE AN ESTIMATION BASED UPON HYDRAULIC AND HYDROLOGIC MODELING; THE REVISED GRADING PLAN AFTER PHASE I WILL ENSURE THAT THE PROPER WETLAND HYDROLOGY IS MET PER PROPOSED VEGETATION COMMUNITIES.



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

# DRAFT DESIGN

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| DESIGNED: - | SCALE: |
| DESIGNED: - | CHECKED: M. SPILLANE |
| RECOMMENDED: - | APPROVED: M. SPILLANE |

SKAGIT ENVIRONMENTAL BANK
PHASE II
REFERENCE DRAWING

GRADING PROFILES

JUNE 2006

04-02822-003

R-7

SHEET NO: 22 OF 26

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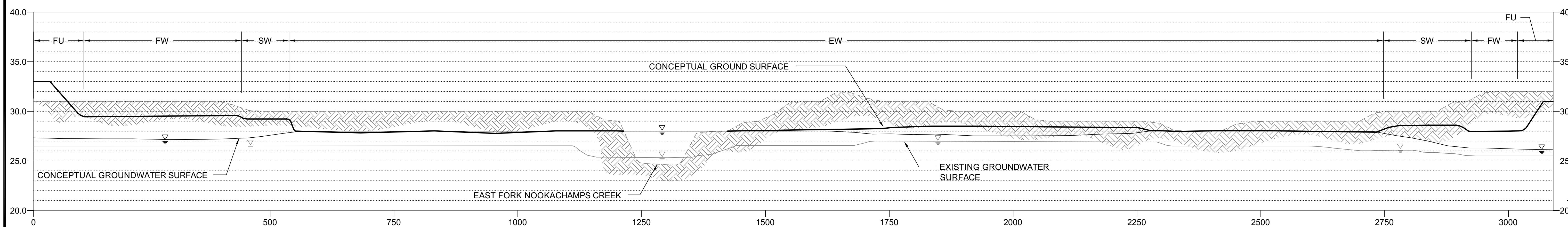
Plot Date: 7/21/2006 2:02 PM
Cad User: Tom Griga


## PROFILE 2 - EXISTING ELEVATIONS

2 / R-6

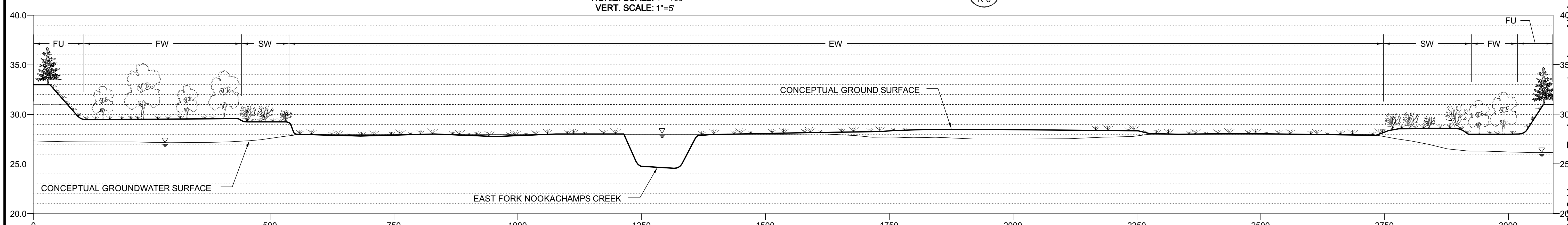
HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




## PROFILE 2 - CONCEPTUAL PHASE II ELEVATIONS

2 / R-6

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




## PROFILE 2 - CONCEPTUAL PHASE II ELEVATIONS AND VEGETAION COMMUNITIES

2 / R-6

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'
VEGETATION: = N.T.S.

## NOTE:

1. GROUNDWATER SURFACE ELEVATIONS ARE BASED ON 2005 SECOND QUARTERGROUNDWATER ELEVATIONS (APRIL, MAY, AND JUNE.).
2. ELEVATIONS REFERENCE DISTANCE IN FEET ABOVE MEAN SEA LEVEL, VERTICAL DATUM NAVD 88.
3. THE CONCEPTUAL WATER LEVELS ARE AN ESTIMATION BASED UPON HYDRAULIC AND HYDROLOGIC MODELING; THE REVISED GRADING PLAN AFTER PHASE I WILL ENSURE THAT THE PROPER WETLAND HYDROLOGY IS MET PER PROPOSED VEGETATION COMMUNITIES.

# DRAFT DESIGN

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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SCALE:
DESIGNED: -
CHECKED: M. SPILLANE
RECOMMENDED: -
APPROVED: M. SPILLANE

# SKAGIT ENVIRONMENTAL BANK PHASE II REFERENCE DRAWING

GRADING PROFILES

JUNE 2006

04-02822-003

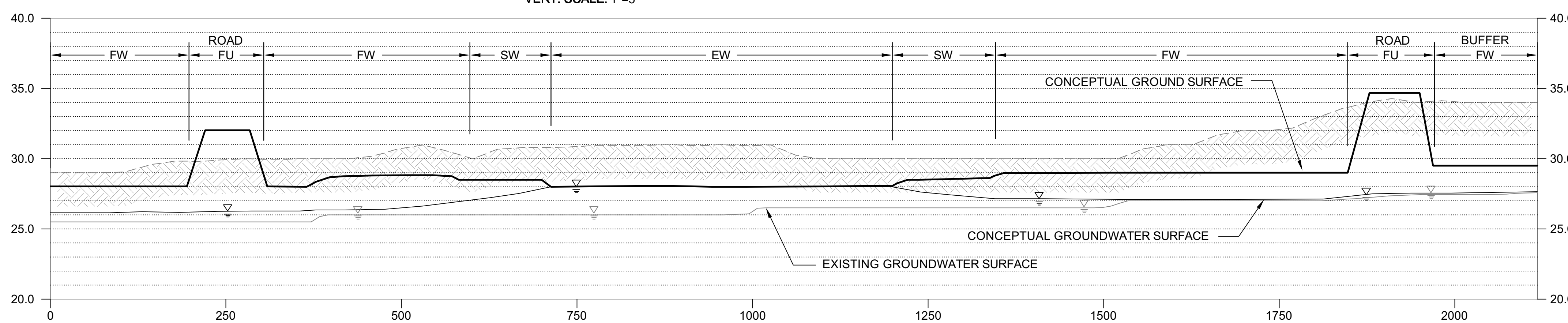
R-8

SHEET NO: 23 OF 26

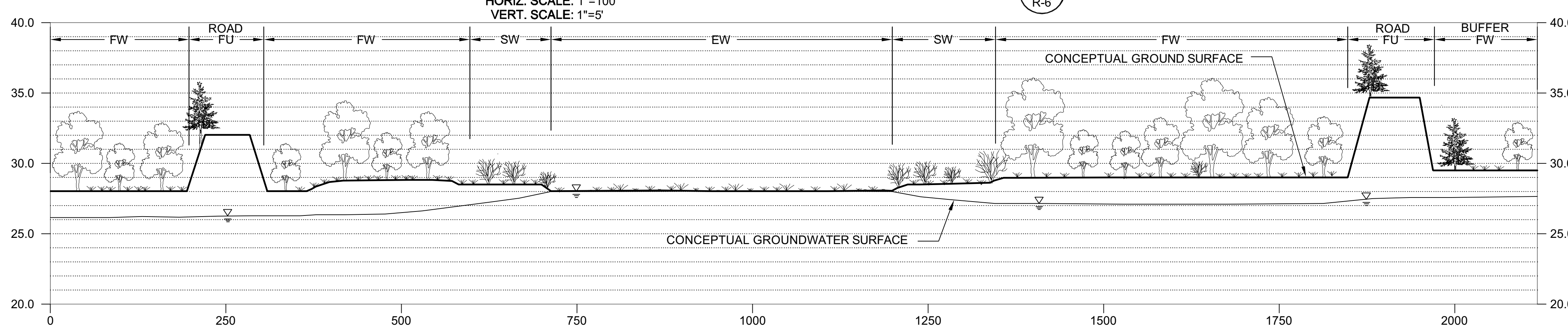


Path: O:\proj\04-02822-003\Cad\Dwgs\Revision No 2 Set\R-8.dwg
Plot Date: 7/21/2006 2:02 PM
Cad User: Tom Griga


PROFILE 3 - EXISTING ELEVATIONS (3 / R-6)
HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




PROFILE 3 - CONCEPTUAL PHASE II ELEVATIONS (3 / R-6)
HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




PROFILE 3 - CONCEPTUAL PHASE II ELEVATIONS AND VEGETAION COMMUNITIES (3 / R-6)
HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'
VEGETATION: = N.T.S.

## NOTE:

1. GROUNDWATER SURFACE ELEVATIONS ARE BASED ON 2005 SECOND QUARTERGROUNDWATER ELEVATIONS (APRIL, MAY, AND JUNE.).
2. ELEVATIONS REFERENCE DISTANCE IN FEET ABOVE MEAN SEA LEVEL, VERTICAL DATUM NAVD 88.
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**DRAFT DESIGN**



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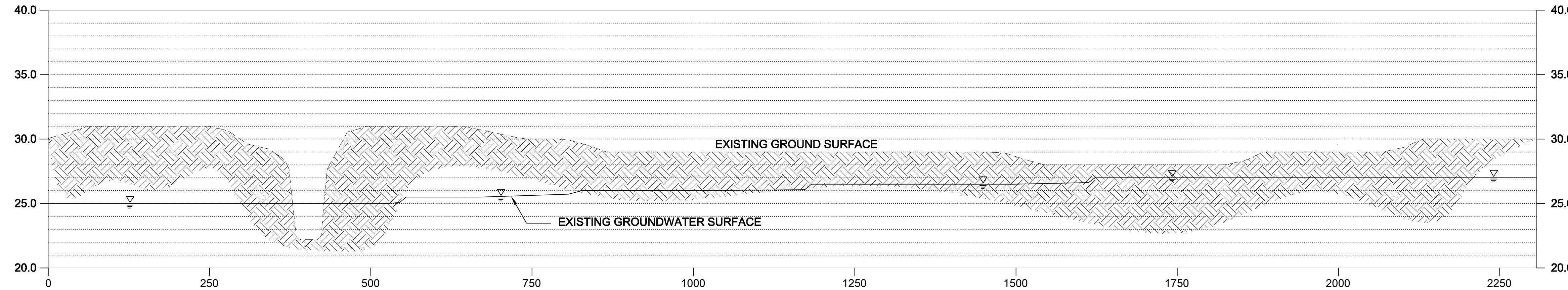
| DESIGNED: - | SCALE: |
| DESIGNED: - | CHECKED: M. SPILLANE |
| RECOMMENDED: - | APPROVED: M. SPILLANE |

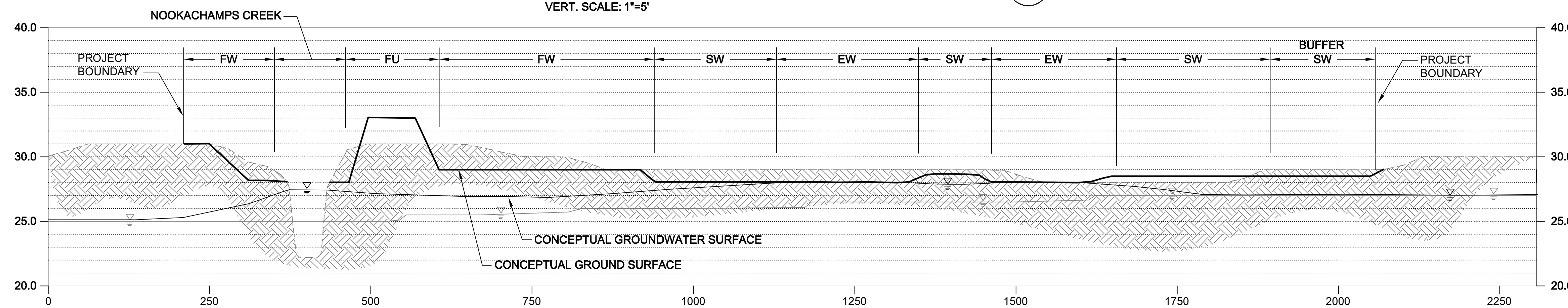
SKAGIT ENVIRONMENTAL BANK
PHASE II
REFERENCE DRAWING
GRADING PROFILES

JUNE 2006
04-02822-003
R-9
SHEET NO: 24 OF 26



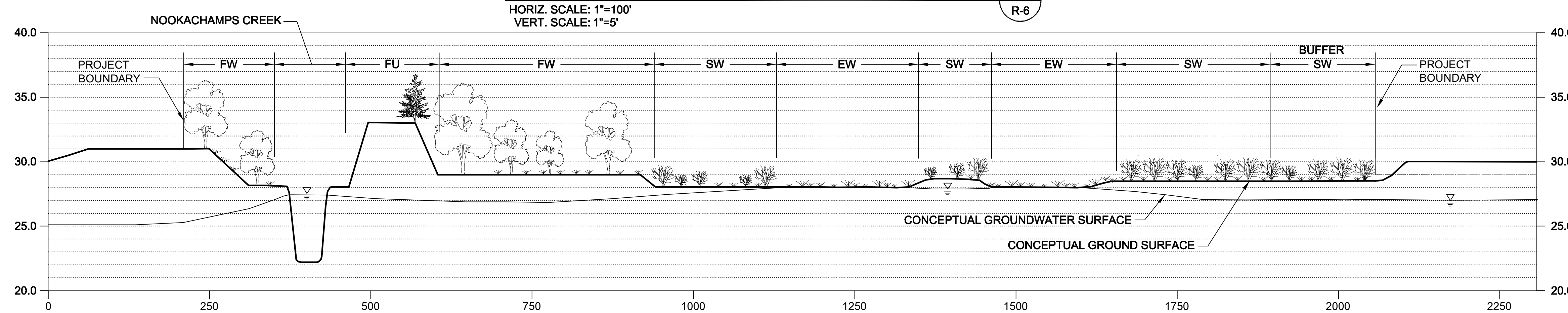

## PROFILE 4 - EXISTING ELEVATIONS
4
R-6

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




## PROFILE 4 - CONCEPTUAL PHASE II ELEVATIONS
4
R-6

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'




## PROFILE 4 - CONCEPTUAL PHASE II ELEVATIONS AND VEGETAION COMMUNITIES
4
R-6

HORIZ. SCALE: 1"=100'
VERT. SCALE: 1"=5'
VEGETATION: = N.T.S.

NOTE:

1. GROUNDWATER SURFACE ELEVATIONS ARE BASED ON 2005 SECOND QUARTERGROUNDWATER ELEVATIONS (APRIL, MAY, AND JUNE.).
2. ELEVATIONS REFERENCE DISTANCE IN FEET ABOVE MEAN SEA LEVEL, VERTICAL DATUM NAVD 88.
3. THE CONCEPTUAL WATER LEVELS ARE AN ESTIMATION BASED UPON HYDRAULIC AND HYDROLOGIC MODELING; THE REVISED GRADING PLAN AFTER PHASE I WILL ENSURE THAT THE PROPER WETLAND HYDROLOGY IS MET PER PROPOSED VEGETATION COMMUNITIES.

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| DESIGNED: - | CHECKED: M. SPILLANE |
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SKAGIT ENVIRONMENTAL BANK
PHASE II
REFERENCE DRAWING
GRADING CROSS-SECTIONS

JUNE 2006
04-02822-003
R-10
SHEET NO: 25 OF 26

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY



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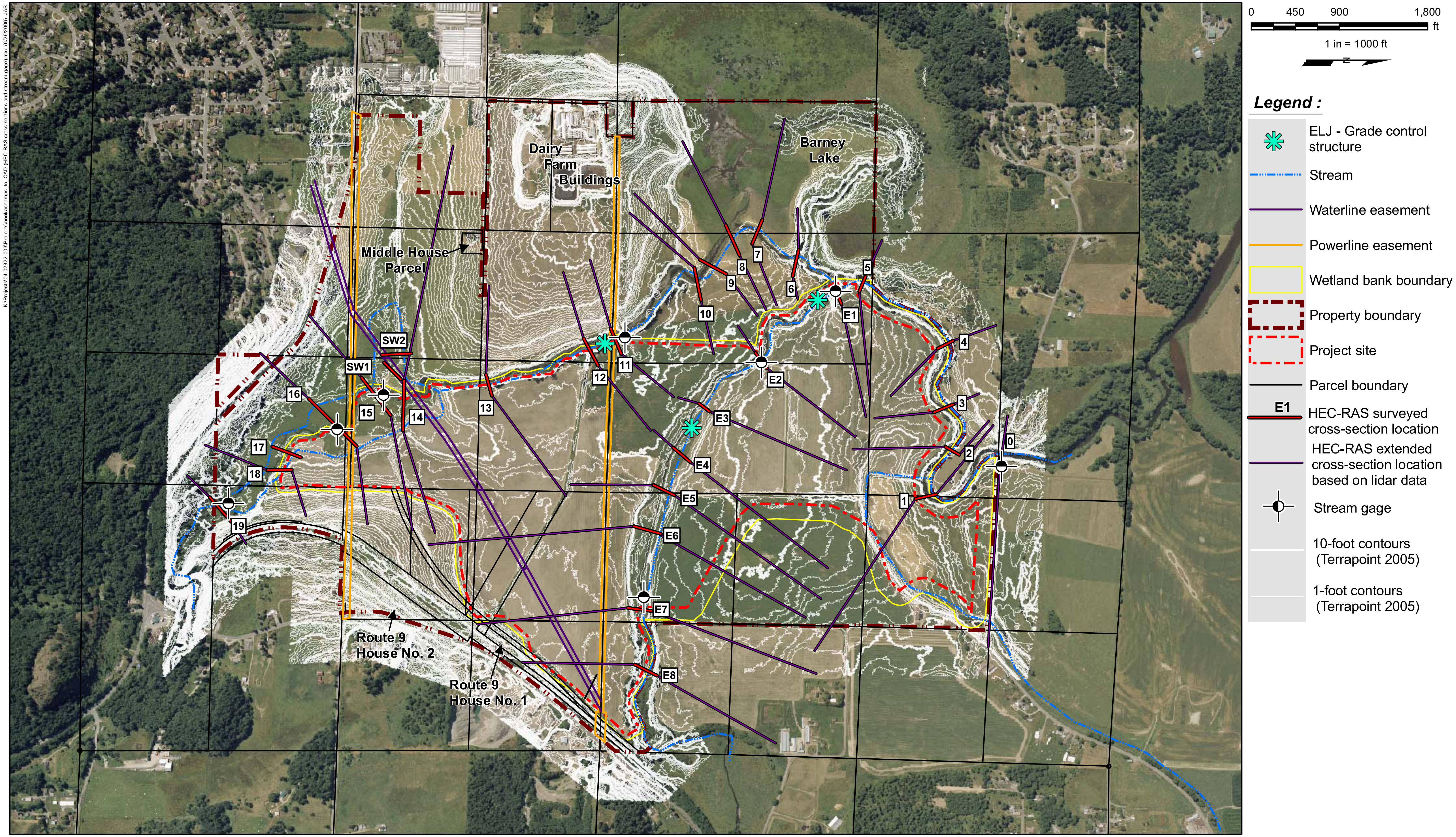
Cad User: Tom Griga

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DRAWN:
DESIGNED:
CHECKED: C. BARTON
DESIGNED:
APPROVED: M. SPILLANE

# SKAGIT ENVIRONMENTAL BANK

## HEC-RAS CROSS SECTION LOCATIONS AND STREAM GAGE

DATE: JUNE 2006
PROJECT NO: 04-02822-003
DRAWING NO: R-11
SHEET NO: 26 of 26

# APPENDIX C

# HEC-RAS Modeling Data

# Existing Conditions

| Cross Section | Growing Season | No Skagit Backwater | | | Moderate Skagit Backwater | | | High Skagit Backwater | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-year | 25-year | 100-year | 2-year | 25-year | 100-year | 2-year | 25-year | 100-year |
| XS0 | 22.3 | 28.7 | 33.6 | 34.9 | 36.9 | 36.9 | 36.9 | 47.2 | 47.2 | 47.2 |
| XS1 | 22.7 | 29.5 | 34.5 | 35.7 | 36.9 | 37.0 | 37.1 | 47.2 | 47.2 | 47.2 |
| XS2 | 22.8 | 29.6 | 34.6 | 35.9 | 36.9 | 37.0 | 37.2 | 47.2 | 47.2 | 47.2 |
| XS3 | 22.8 | 29.7 | 34.7 | 36.0 | 36.9 | 37.1 | 37.3 | 47.2 | 47.2 | 47.2 |
| XS4 | 22.8 | 29.7 | 34.6 | 35.7 | 36.9 | 37.0 | 37.1 | 47.2 | 47.2 | 47.2 |
| XS5 | 22.9 | 29.9 | 35.0 | 36.6 | 36.9 | 37.2 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS6 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS7 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS8 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS9 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS10 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| | | | | | **ELJ** | | | | | |
| XS11 | 23.1 | 30.0 | 35.1 | 36.7 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS12 | 23.1 | 30.1 | 35.1 | 36.7 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS13 | 23.1 | 30.2 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS14 | 23.3 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS15 | 23.5 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS16 | 23.5 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS18 | 23.4 | 30.3 | 35.2 | 36.8 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS19 | 28.6 | 30.7 | 35.3 | 36.9 | 37.0 | 37.3 | 37.9 | 47.2 | 47.2 | 47.3 |
| **East Fork** | | | | | | | | | | |
| E1 | 23.9 | 30.1 | 35.1 | 36.7 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| | | | | | **ELJ** | | | | | |
| E2 | 24.5 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E3 | 24.6 | 30.4 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| | | | | | **ELJ** | | | | | |
| E4 | 24.6 | 30.5 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E5 | 24.7 | 30.6 | 35.2 | 36.8 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E6 | 25.0 | 30.7 | 35.2 | 36.8 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E7 | 25.8 | 31.5 | 35.4 | 36.9 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E8 | 26.1 | 31.9 | 35.7 | 37.1 | 37.0 | 37.4 | 37.9 | 47.2 | 47.2 | 47.3 |

Note: Water surface elevations in feet above NAVD 88.

# After Proposed Modifications

| Cross Section | Growing Season | No Skagit Backwater | | | Moderate Skagit Backwater | | | High Skagit Backwater | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 2-year | 25-year | 100-year | 2-year | 25-year | 100-year | 2-year | 25-year | 100-year |
| XS0 | 22.3 | 28.7 | 33.6 | 34.9 | 36.9 | 36.9 | 36.9 | 47.2 | 47.2 | 47.2 |
| XS1 | 22.7 | 29.5 | 34.5 | 35.7 | 36.9 | 37.0 | 37.1 | 47.2 | 47.2 | 47.2 |
| XS2 | 22.8 | 29.6 | 34.6 | 35.9 | 36.9 | 37.0 | 37.2 | 47.2 | 47.2 | 47.2 |
| XS3 | 22.8 | 29.7 | 34.7 | 36.0 | 36.9 | 37.1 | 37.3 | 47.2 | 47.2 | 47.2 |
| XS4 | 22.8 | 29.7 | 34.6 | 35.7 | 36.9 | 37.0 | 37.1 | 47.2 | 47.2 | 47.2 |
| XS5 | 22.9 | 29.9 | 35.0 | 36.6 | 36.9 | 37.2 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS6 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS7 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS8 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS9 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS10 | 23.0 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| | | | | | **ELJ** | | | | | |
| XS11 | 23.4 | 30.0 | 35.1 | 36.6 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS12 | 23.4 | 30.1 | 35.1 | 36.7 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| XS13 | 24.0 | 30.2 | 35.1 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS14 | 24.1 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS15 | 24.1 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS16 | 24.2 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS18 | 24.1 | 30.3 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| XS19 | 28.5 | 30.7 | 35.3 | 36.9 | 37.0 | 37.3 | 37.9 | 47.2 | 47.2 | 47.3 |
| **East Fork** | | | | | | | | | | |
| E1 | 23.9 | 30.1 | 35.1 | 36.7 | 36.9 | 37.3 | 37.7 | 47.2 | 47.2 | 47.2 |
| | | | | | **ELJ** | | | | | |
| E2 | 26.3 | 30.6 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E3 | 26.3 | 30.7 | 35.2 | 36.7 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| | | | | | **ELJ** | | | | | |
| E4 | 26.6 | 30.8 | 35.2 | 36.8 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E5 | 26.6 | 30.8 | 35.2 | 36.8 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E6 | 26.6 | 31.0 | 35.2 | 36.8 | 36.9 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E7 | 26.9 | 31.6 | 35.4 | 36.9 | 37.0 | 37.3 | 37.8 | 47.2 | 47.2 | 47.2 |
| E8 | 27.0 | 32.0 | 35.7 | 37.1 | 37.0 | 37.4 | 37.9 | 47.2 | 47.2 | 47.3 |

Note: Water surface elevations in feet above NAVD 88.

## APPENDIX D

# HEC-RAS Sensitivity Analysis

# Sensitivity Analysis of Growing Season Hydraulics

| Cross Section | Existing | | Proposed | | Change | |
|---|---|---|---|---|---|---|
| | Low (80%) | High (120%) | Low (80%) | High (120%) | Low (80%) | High (120%) |
| XS0 | 21.9 | 22.6 | 21.9 | 22.6 | 0.0 | 0.0 |
| XS1 | 22.3 | 23.1 | 22.3 | 23.1 | 0.0 | 0.0 |
| XS2 | 22.4 | 23.2 | 22.4 | 23.2 | 0.0 | 0.0 |
| XS3 | 22.4 | 23.2 | 22.4 | 23.2 | 0.0 | 0.0 |
| XS4 | 22.4 | 23.2 | 22.4 | 23.2 | 0.0 | 0.0 |
| XS5 | 22.5 | 23.3 | 22.5 | 23.3 | 0.0 | 0.0 |
| XS6 | 22.6 | 23.4 | 22.6 | 23.4 | 0.0 | 0.0 |
| XS7 | 22.6 | 23.4 | 22.6 | 23.4 | 0.0 | 0.0 |
| XS8 | 22.6 | 23.4 | 22.6 | 23.4 | 0.0 | 0.0 |
| XS9 | 22.6 | 23.4 | 22.6 | 23.4 | 0.0 | 0.0 |
| XS10 | 22.6 | 23.4 | 22.6 | 23.4 | 0.0 | 0.0 |
| | | | **ELJ** | | | |
| XS11 | 22.7 | 23.5 | 23.9 | 24.0 | 1.2 | 0.5 |
| XS12 | 22.7 | 23.5 | 23.9 | 24.0 | 1.2 | 0.5 |
| XS13 | 22.7 | 23.5 | 23.9 | 24.0 | 1.2 | 0.5 |
| XS14 | 22.9 | 23.7 | 24.0 | 24.1 | 1.1 | 0.4 |
| XS15 | 23.1 | 23.9 | 24.0 | 24.2 | 1.0 | 0.4 |
| XS16 | 23.1 | 23.9 | 24.0 | 24.3 | 1.0 | 0.4 |
| XS18 | 23.8 | 23.9 | 24.0 | 24.2 | 0.2 | 0.3 |
| XS19 | 28.3 | 28.7 | 28.3 | 28.7 | 0.0 | 0.0 |
| **East Fork** | | | | | | |
| E1 | 23.7 | 24.0 | 23.7 | 24.0 | 0.0 | 0.0 |
| | | | **ELJ** | | | |
| E2 | 24.3 | 24.7 | 26.1 | 26.5 | 1.8 | 1.8 |
| E3 | 24.3 | 24.8 | 26.1 | 26.5 | 1.8 | 1.8 |
| | | | **ELJ** | | | |
| E4 | 24.3 | 24.9 | 26.3 | 26.8 | 2.0 | 1.9 |
| E5 | 24.4 | 25.0 | 26.3 | 26.8 | 1.9 | 1.8 |
| E6 | 24.7 | 25.3 | 26.4 | 26.9 | 1.7 | 1.6 |
| E7 | 25.5 | 26.1 | 26.6 | 27.2 | 1.1 | 1.0 |
| E8 | 25.8 | 26.4 | 26.7 | 27.3 | 0.9 | 0.9 |

# APPENDIX E

# Ground Water Monitoring Well Data

# Nookachamps Creek Monitoring Well Data (2004-2006)

| Well # | 9/5/04 | 9/24/04 | 10/3/04 | 10/25/04 | 11/6/04 | 11/20/04 | 12/5/04 | 12/17/04 |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.08 | 25.80 | 25.00 | 25.87 | 26.31 | 26.23 | 26.42 | NA |
| 2 | 23.23 | 24.88 | 23.24 | 24.49 | 24.93 | 24.80 | 26.11 | NA |
| 3 | 23.66 | 27.11 | 25.34 | 26.95 | 27.16 | 27.16 | 27.18 | NA |
| 4 | NA | NA | 25.84 | 26.68 | 28.89 | 28.10 | 28.83 | NA |
| 5 | 23.09 | 25.15 | 23.32 | 24.16 | 25.98 | 25.74 | 26.65 | NA |
| 6 | 26.09 | 27.57 | 25.13 | 26.86 | 30.10 | 28.54 | 30.48 | NA |
| 7 | NA | NA | 27.13 | 28.84 | 29.91 | 30.18 | 30.62 | NA |
| 8 | 24.21 | 25.59 | 25.27 | 25.72 | 27.24 | 27.51 | 28.38 | NA |
| 9 | 28.81 | 29.27 | 27.69 | 28.89 | 29.95 | 29.90 | 30.20 | NA |
| 10 | 24.93 | 26.61 | 25.47 | 26.09 | 27.10 | 27.54 | 30.44 | NA |
| 11 | 26.06 | 26.99 | 26.26 | 26.55 | 27.64 | 27.95 | 30.33 | NA |
| 12 | 25.85 | 26.51 | 26.34 | 26.46 | 27.36 | 27.68 | 29.67 | NA |
| 13 | 25.87 | 26.63 | 26.22 | 26.59 | 27.64 | 28.16 | 29.80 | NA |
| 14 | 24.57 | 26.48 | 23.77 | 25.33 | 27.25 | 26.73 | 28.29 | NA |
| 15 | 24.71 | 26.00 | 25.21 | 24.76 | 27.83 | 27.53 | 28.68 | NA |
| 16 | 24.28 | 25.25 | 24.43 | 25.30 | 27.19 | 26.77 | 26.90 | NA |
| 17 | 22.86 | 24.23 | 23.67 | 24.29 | 26.67 | 26.55 | 28.09 | NA |
| 18 | 23.31 | 24.81 | 23.45 | 24.04 | 25.83 | 25.69 | 27.70 | NA |
| 19 | 22.30 | 25.21 | 24.40 | 25.69 | NA | NA | NA | 28.06 |
| 20 | 22.30 | 23.44 | 23.09 | 23.49 | 24.55 | 25.22 | 28.23 | NA |
| 21 | 21.64 | 23.24 | 23.32 | 23.94 | 25.29 | 26.31 | 30.06 | NA |
| 22 | 22.55 | 23.89 | 23.10 | 24.08 | 33.50 | 25.78 | 28.46 | NA |
| 23 | 24.59 | 25.72 | 25.45 | 24.02 | 26.94 | 27.23 | 28.62 | 29.40 |
| 24 | NA | NA | 27.17 | 27.85 | 29.94 | 28.82 | 29.04 | NA |
| 25 | NA | NA | 22.53 | 28.13 | 30.07 | 29.80 | 29.85 | NA |
| 26 | NA | NA | NA | NA | 25.68 | 25.57 | 26.54 | NA |
| 27 | NA | NA | NA | NA | 24.51 | 24.18 | 25.31 | NA |
| 28 | NA | NA | NA | NA | 23.69 | 23.26 | 24.49 | NA |
| 29 | NA | NA | NA | NA | NA | NA | NA | NA |
| 30 | NA | NA | NA | NA | NA | NA | NA | NA |
| 31 | NA | NA | NA | NA | NA | NA | NA | NA |
| 33 | NA | NA | NA | NA | NA | NA | NA | NA |
| 34 | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
Water level elevations are in feet above NAVD88.
NA = Well data was not available.
D = Well was dry.

| Well # | 1/8/05 | 2/5/05 | 2/26/05 | 3/12/05 | 3/24/05 | 4/10/05 | 4/31/2005 | 5/21/05 |
|---|---|---|---|---|---|---|---|---|
| 1 | 25.87 | 26.17 | 25.56 | 25.49 | 26.10 | 26.29 | 25.01 | 25.61 |
| 2 | 24.97 | 24.91 | 23.38 | 23.10 | 23.91 | 25.28 | 23.54 | 24.32 |
| 3 | 26.87 | 26.95 | 25.85 | 25.55 | 25.95 | 26.78 | 24.90 | 26.20 |
| 4 | 27.53 | 28.09 | 25.87 | 25.77 | 26.55 | 28.45 | 25.79 | D |
| 5 | 24.70 | 25.41 | 23.43 | 23.16 | 23.90 | 26.09 | 23.41 | 23.72 |
| 6 | 28.33 | 28.67 | 25.68 | 24.98 | 27.00 | 27.49 | 23.68 | D |
| 7 | 29.44 | 29.57 | 28.41 | 27.81 | 29.09 | 30.36 | 27.97 | 27.42 |
| 8 | 26.92 | 27.18 | 26.36 | 25.94 | 26.67 | 27.87 | 26.08 | 25.46 |
| 9 | 29.39 | 29.99 | 27.15 | 25.78 | 28.14 | 29.65 | 25.23 | 21.04 |
| 10 | 26.76 | 27.39 | 26.19 | 25.80 | 26.19 | 27.80 | 26.46 | 26.84 |
| 11 | 28.02 | 28.58 | 27.40 | 26.89 | 27.14 | 28.94 | 27.66 | 27.08 |
| 12 | 27.73 | 28.16 | 27.36 | 27.00 | 27.01 | 28.53 | 27.39 | 27.17 |
| 13 | 28.57 | 28.96 | 27.43 | 26.95 | NA | 29.11 | 27.55 | 27.20 |
| 14 | 26.74 | 26.83 | 25.89 | 25.49 | 25.66 | 27.36 | 25.80 | 26.26 |
| 15 | 27.29 | 28.44 | 26.22 | 25.57 | 25.72 | 27.67 | 26.28 | 25.64 |
| 16 | 26.68 | 26.36 | 25.80 | 24.93 | 24.81 | 26.41 | 24.77 | 24.48 |
| 17 | 25.66 | 26.47 | 24.26 | 24.35 | 23.46 | 26.81 | 25.34 | 23.27 |
| 18 | 24.55 | 25.18 | 23.81 | 23.33 | 23.74 | 26.02 | 24.30 | 23.62 |
| 19 | 24.02 | 24.43 | 22.85 | 25.44 | 22.31 | 27.54 | 25.74 | 21.44 |
| 20 | 25.22 | 26.72 | 24.01 | 24.02 | 22.93 | 26.32 | 25.16 | 22.98 |
| 21 | 28.36 | 23.92 | 21.94 | 25.73 | 20.48 | 28.04 | 26.64 | 19.91 |
| 22 | 25.94 | 27.04 | 24.15 | 24.45 | 24.23 | 25.93 | 25.62 | 24.30 |
| 23 | 27.59 | 23.33 | 22.42 | 26.78 | 22.18 | 28.01 | 27.07 | 21.66 |
| 24 | 29.19 | 29.09 | 27.82 | 27.53 | 27.96 | 28.43 | 27.16 | D |
| 25 | 29.82 | 30.20 | 28.16 | 27.63 | 28.25 | 29.83 | 26.66 | 26.26 |
| 26 | 24.81 | 25.34 | 23.75 | 24.09 | 24.27 | 27.37 | 24.44 | 22.77 |
| 27 | 23.34 | 23.98 | 22.87 | 23.58 | 22.69 | 25.66 | 24.34 | 22.93 |
| 28 | 23.20 | 23.94 | 22.29 | 21.83 | 21.94 | 23.59 | 22.64 | 21.69 |
| 29 | NA | NA | NA | NA | NA | NA | NA | NA |
| 30 | NA | NA | NA | NA | NA | NA | NA | NA |
| 31 | NA | NA | NA | NA | NA | NA | NA | NA |
| 33 | NA | NA | NA | NA | NA | NA | NA | NA |
| 34 | NA | NA | NA | NA | NA | NA | NA | NA |

Notes:
Water level elevations are in feet above NAVD88.
NA = Well data was not available.
D = Well was dry.

| Well # | 6/10/05 | 6/27/05 | 7/29/05 | 9/13/05 | 10/22/05 | 11/17/05 | 12/19/05 | 2/11/06 |
|---|---|---|---|---|---|---|---|---|
| 1 | 23.16 | D | D | D | 25.37 | 26.15 | 25.48 | 26.25 |
| 2 | 21.73 | 21.23 | 21.00 | D | 24.32 | 24.65 | 23.32 | 25.03 |
| 3 | 23.78 | 23.68 | 22.83 | D | 24.22 | 27.08 | 26.08 | 26.76 |
| 4 | 24.68 | 23.74 | D | 23.42 | 25.64 | 28.03 | 26.54 | 28.51 |
| 5 | 22.54 | D | D | D | 23.85 | 25.46 | 23.82 | 25.82 |
| 6 | D | D | D | D | D | 29.12 | 27.13 | 27.82 |
| 7 | 26.48 | 25.82 | 25.32 | D | 26.06 | 29.75 | 28.88 | 30.57 |
| 8 | 24.74 | 24.31 | 23.84 | 22.45 | 23.75 | 26.03 | 26.26 | 27.84 |
| 9 | D | D | D | D | D | 29.82 | 28.43 | 29.20 |
| 10 | 25.53 | 25.30 | 24.68 | 24.37 | 25.72 | 26.75 | 25.57 | 27.37 |
| 11 | 26.46 | 26.12 | D | D | 25.94 | 27.06 | 26.33 | 28.76 |
| 12 | 26.61 | 26.20 | 25.67 | D | 25.45 | 26.47 | 26.72 | 28.18 |
| 13 | 26.53 | 26.13 | 25.42 | D | 25.55 | 26.87 | 26.71 | 29.13 |
| 14 | 24.62 | 24.18 | D | D | 25.19 | 26.59 | 25.23 | 27.17 |
| 15 | 25.04 | 24.66 | 24.02 | 23.20 | 24.58 | 26.80 | NA | 27.99 |
| 16 | 23.79 | 23.36 | 22.58 | 21.49 | 24.51 | 25.41 | 24.49 | 25.85 |
| 17 | 23.48 | 22.94 | 22.45 | 21.43 | 22.60 | 24.37 | 24.29 | 27.46 |
| 18 | 22.92 | 22.75 | 22.24 | 21.52 | 23.79 | 25.40 | 22.81 | 25.99 |
| 19 | 23.55 | 22.60 | 21.51 | D | 22.91 | 23.44 | 26.07 | 27.34 |
| 20 | 23.28 | 22.80 | 22.22 | 21.19 | 21.77 | 24.32 | 24.10 | 27.20 |
| 21 | 23.95 | 23.13 | 22.28 | 21.30 | D | 19.38 | 25.20 | 29.17 |
| 22 | 23.58 | 23.05 | 22.35 | 21.62 | 22.37 | 23.94 | 23.45 | 28.34 |
| 23 | 25.72 | 25.28 | 27.68 | D | 24.14 | 22.69 | 26.64 | 28.15 |
| 24 | 26.13 | 25.65 | 25.34 | D | D | 28.38 | 27.95 | 27.11 |
| 25 | 24.53 | 24.06 | 21.08 | D | D | 29.20 | 28.78 | 30.07 |
| 26 | D | D | D | D | D | 24.41 | 24.83 | 26.47 |
| 27 | 23.45 | D | D | D | 23.55 | 24.01 | 23.75 | 25.12 |
| 28 | D | D | D | D | D | 22.57 | NA | 24.57 |
| 29 | NA | NA | 29.16 | D | 29.57 | 28.46 | 31.40 | 32.81 |
| 30 | NA | NA | 23.08 | 22.38 | 23.92 | 21.68 | 24.96 | 26.98 |
| 31 | NA | NA | 24.80 | D | D | 22.20 | 25.44 | 26.53 |
| 33 | NA | NA | 25.05 | 23.56 | 24.00 | 25.50 | 26.09 | 30.26 |
| 34 | NA | NA | 28.65 | 27.90 | 28.34 | 25.46 | 30.43 | 33.86 |

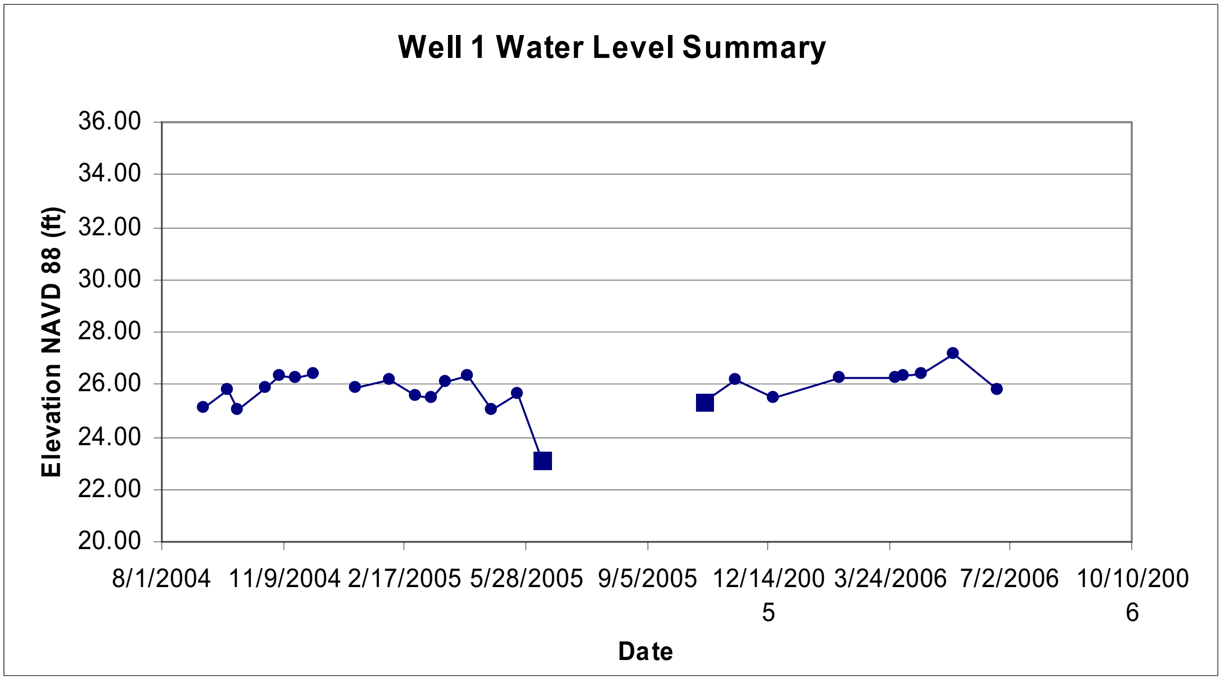
Notes:
Water level elevations are in feet above NAVD88.
NA = Well data was not available.
D = Well was dry.

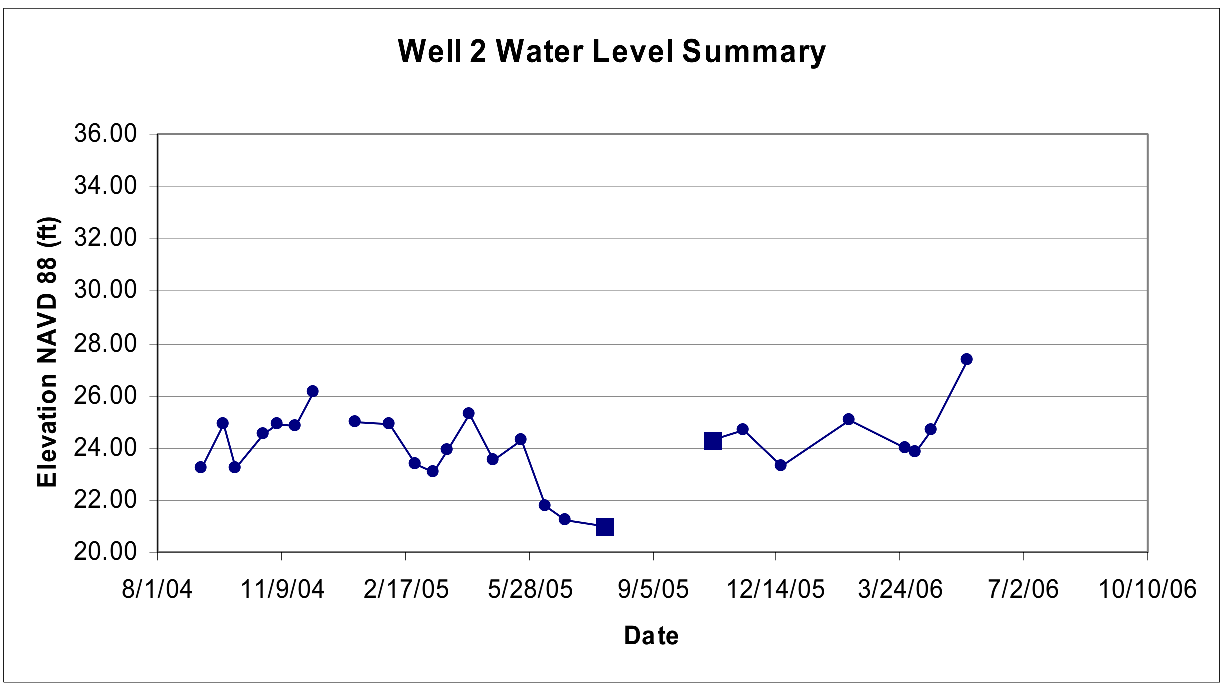
| Well # | 3/29/06 | 4/5/06 | 4/19/06 | 5/17/06 |
|---|---|---|---|---|
| 1 | 26.21 | 26.29 | 26.42 | 27.17 |
| 2 | 23.99 | 23.80 | 24.65 | 27.36 |
| 3 | 26.51 | 26.16 | 26.27 | 26.46 |
| 4 | 26.96 | 26.90 | 28.00 | 24.73 |
| 5 | 24.40 | 24.46 | 25.54 | 25.12 |
| 6 | 28.44 | 27.62 | 27.11 | 26.13 |
| 7 | 29.61 | 29.62 | 30.02 | 26.96 |
| 8 | 26.49 | 26.86 | 27.57 | 25.48 |
| 9 | 28.87 | 29.22 | 29.08 | 25.04 |
| 10 | 26.61 | NA | 27.23 | 27.33 |
| 11 | 27.36 | NA | 28.30 | 27.20 |
| 12 | 27.17 | NA | 27.83 | 26.98 |
| 13 | 27.45 | NA | 28.28 | 27.06 |
| 14 | 26.13 | NA | 27.00 | 25.96 |
| 15 | 26.22 | NA | 27.22 | 25.82 |
| 16 | 24.68 | NA | 25.49 | 26.95 |
| 17 | 25.27 | NA | 26.39 | 24.52 |
| 18 | 24.25 | NA | 25.40 | 25.51 |
| 19 | 26.34 | NA | 27.19 | 24.52 |
| 20 | 25.99 | NA | 26.76 | 24.56 |
| 21 | 26.74 | NA | 27.42 | 25.08 |
| 22 | 25.26 | NA | 25.55 | 25.19 |
| 23 | 26.97 | 27.17 | 27.58 | 26.32 |
| 24 | 28.20 | 28.01 | 27.99 | 26.52 |
| 25 | 29.86 | 29.65 | 29.36 | 25.15 |
| 26 | 25.13 | 25.59 | 26.34 | 23.84 |
| 27 | 24.45 | NA | 24.87 | 26.86 |
| 28 | 22.43 | NA | 23.02 | 28.74 |
| 29 | 32.51 | 32.49 | 32.84 | 30.32 |
| 30 | 25.08 | 25.58 | 26.53 | 25.09 |
| 31 | 25.73 | NA | 26.05 | 26.10 |
| 33 | 28.05 | 28.30 | 29.18 | 26.73 |
| 34 | 31.38 | 31.84 | 32.85 | 30.05 |

Notes:
Water level elevations are in feet above NAVD88.
NA = Well data was not available.
D = Well was dry.

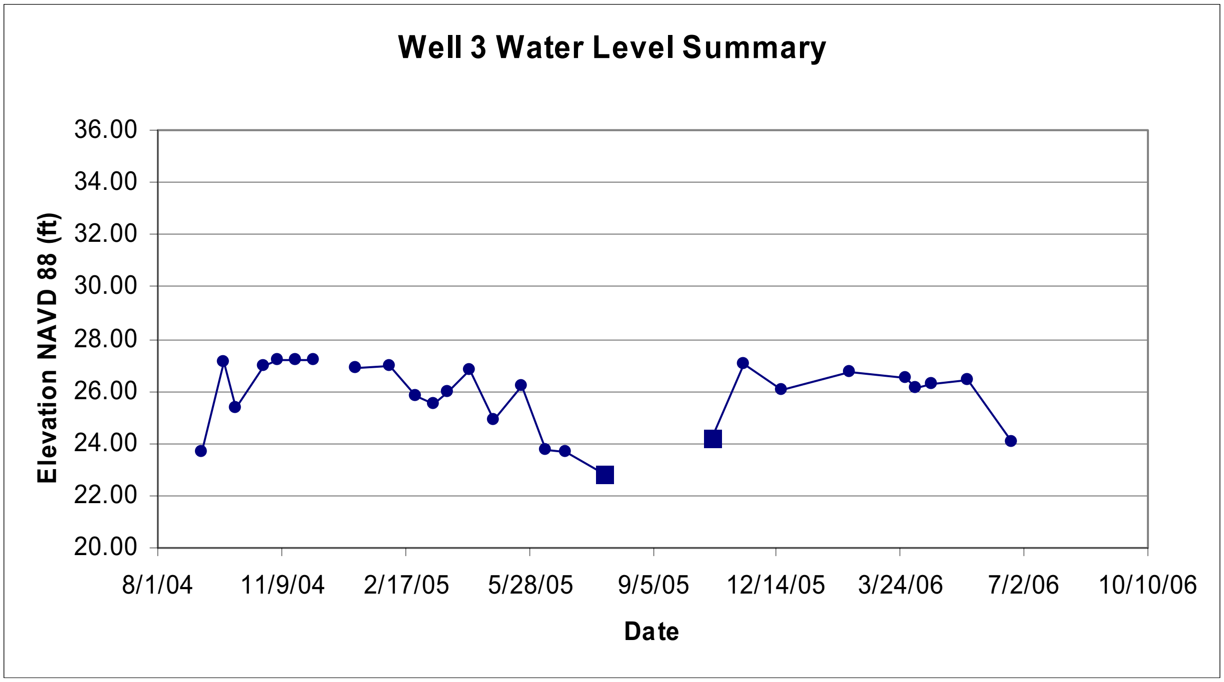
# APPENDIX F

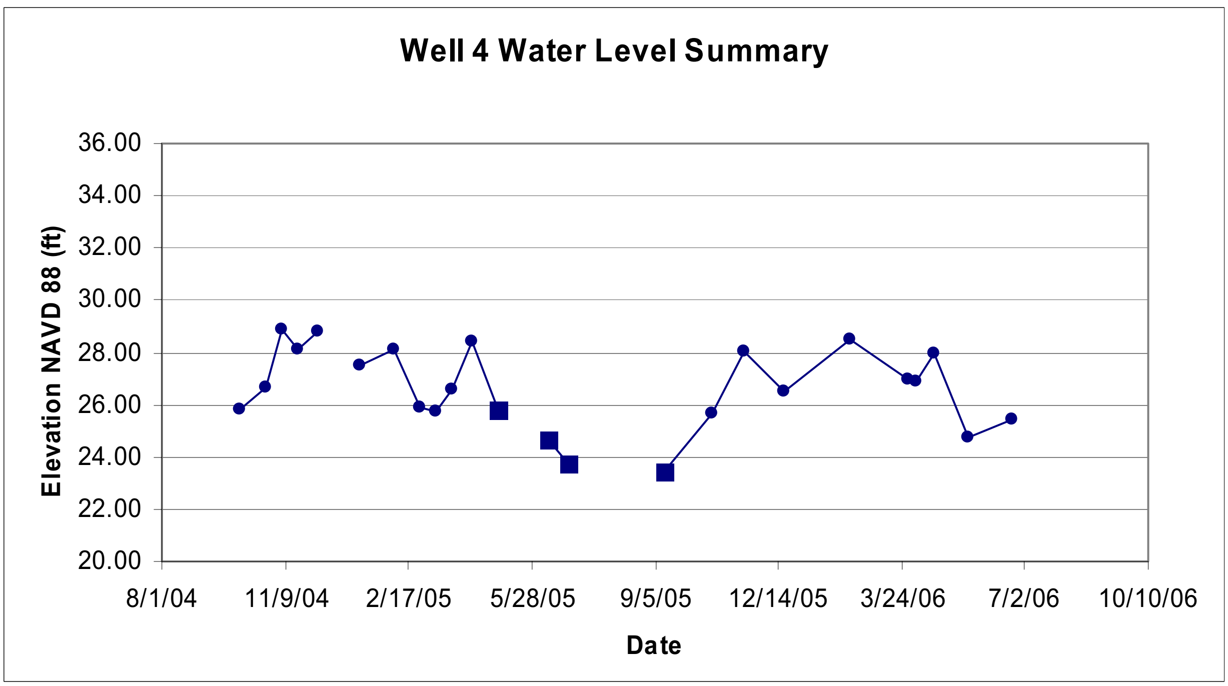
# Ground Water and Stream Gauge Hydrographs




■ Denotes a period where the well was dry

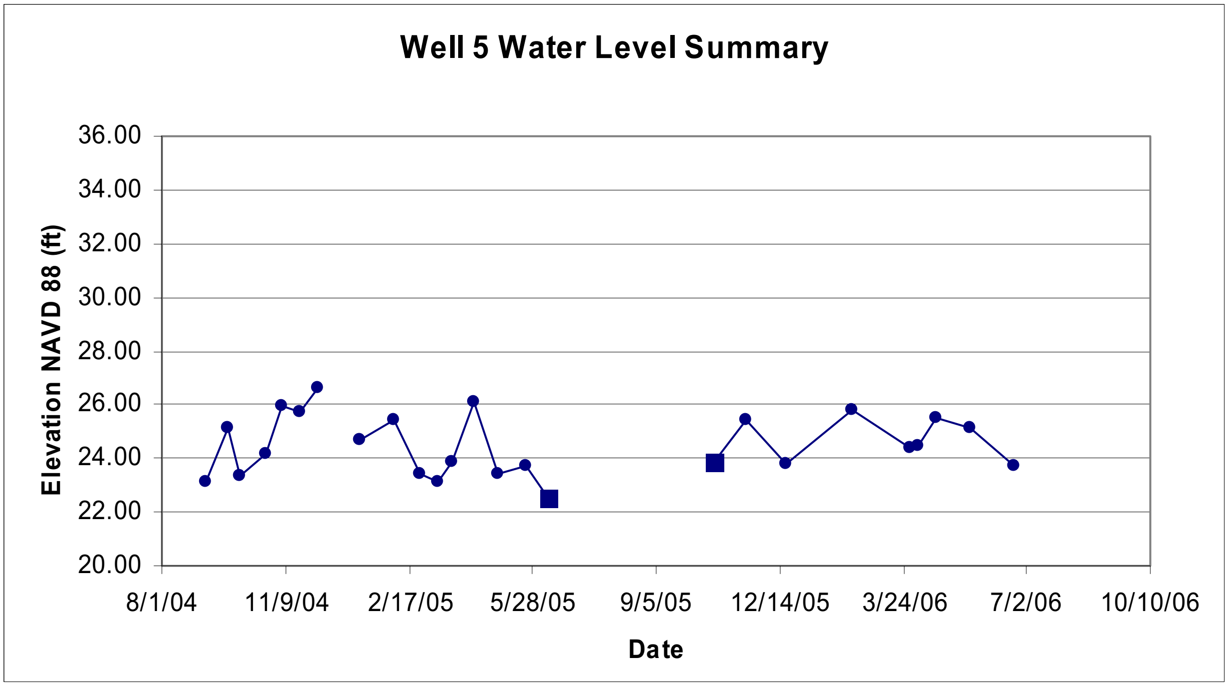


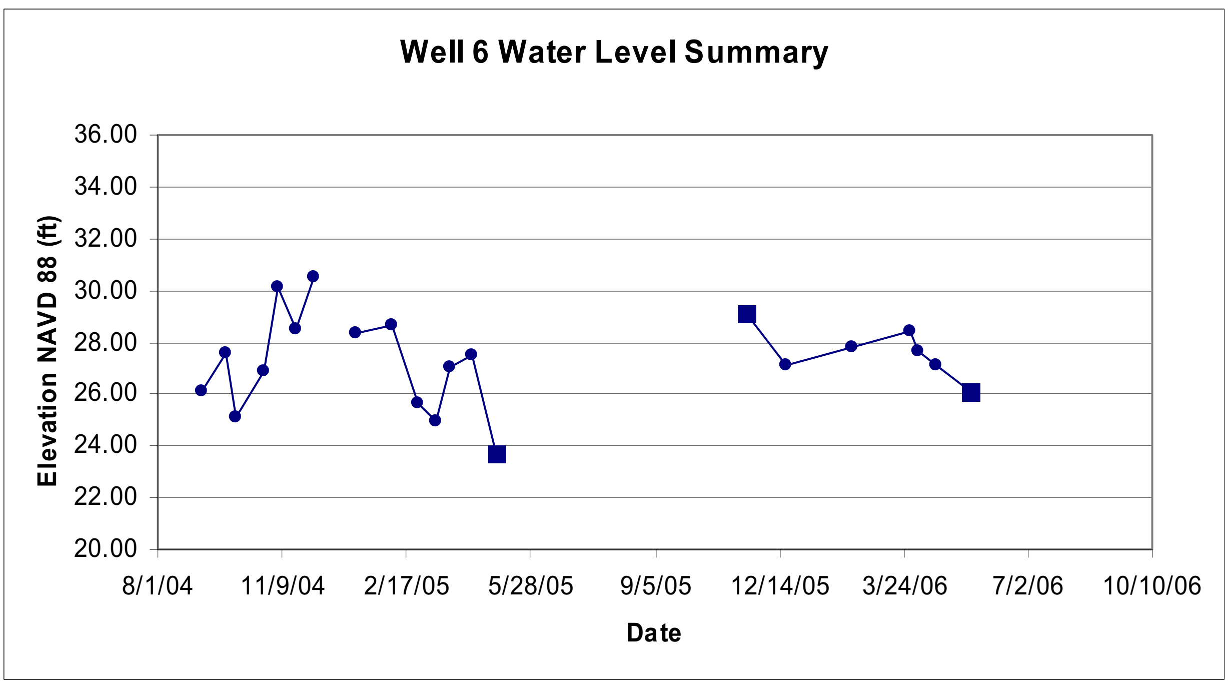





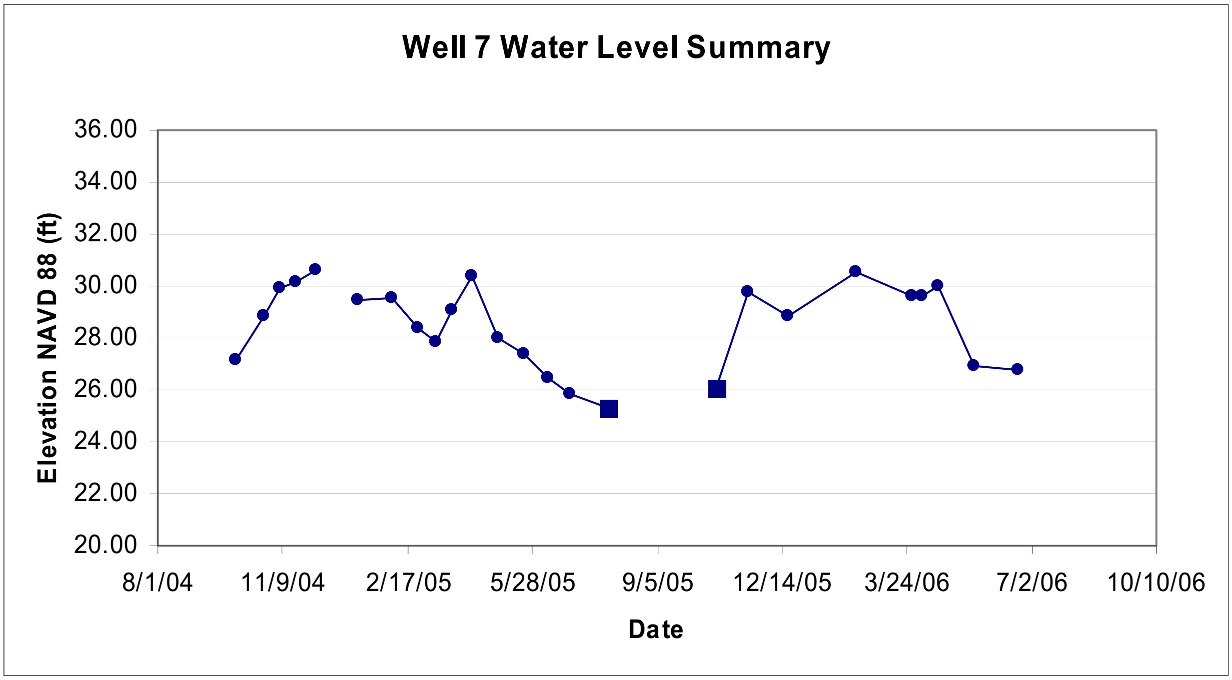
Denotes a period where the well was dry

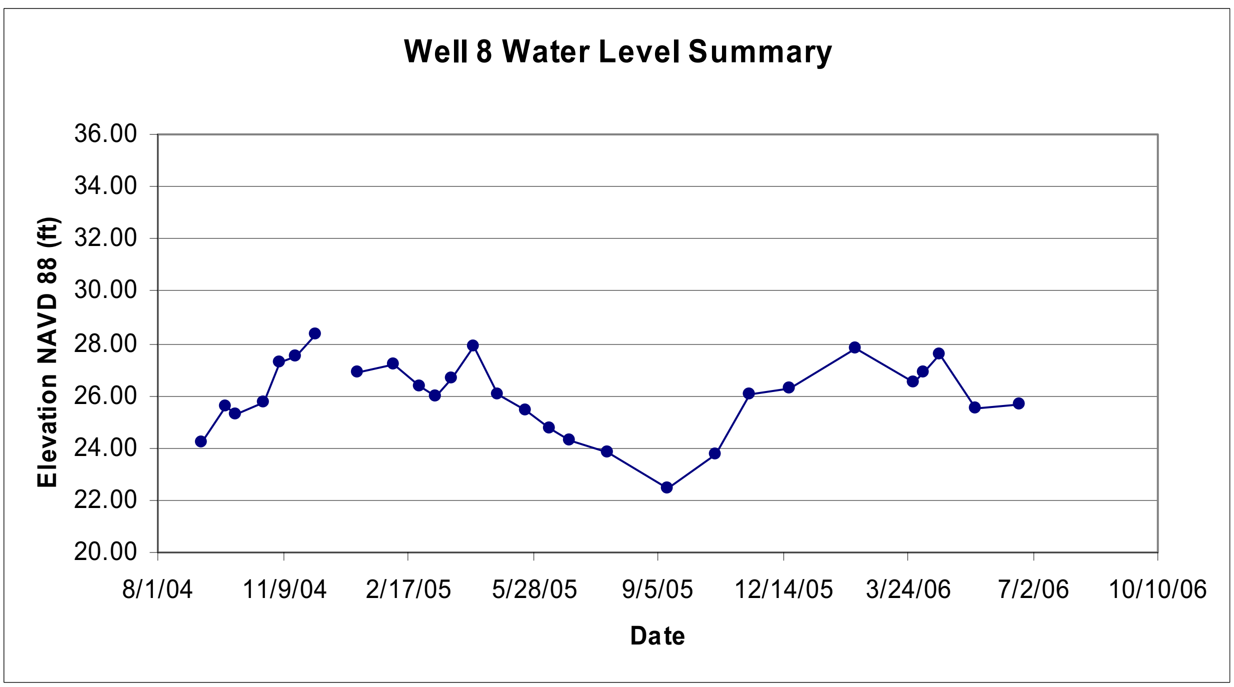
wp4 /04-02822-003 apx-f.doc



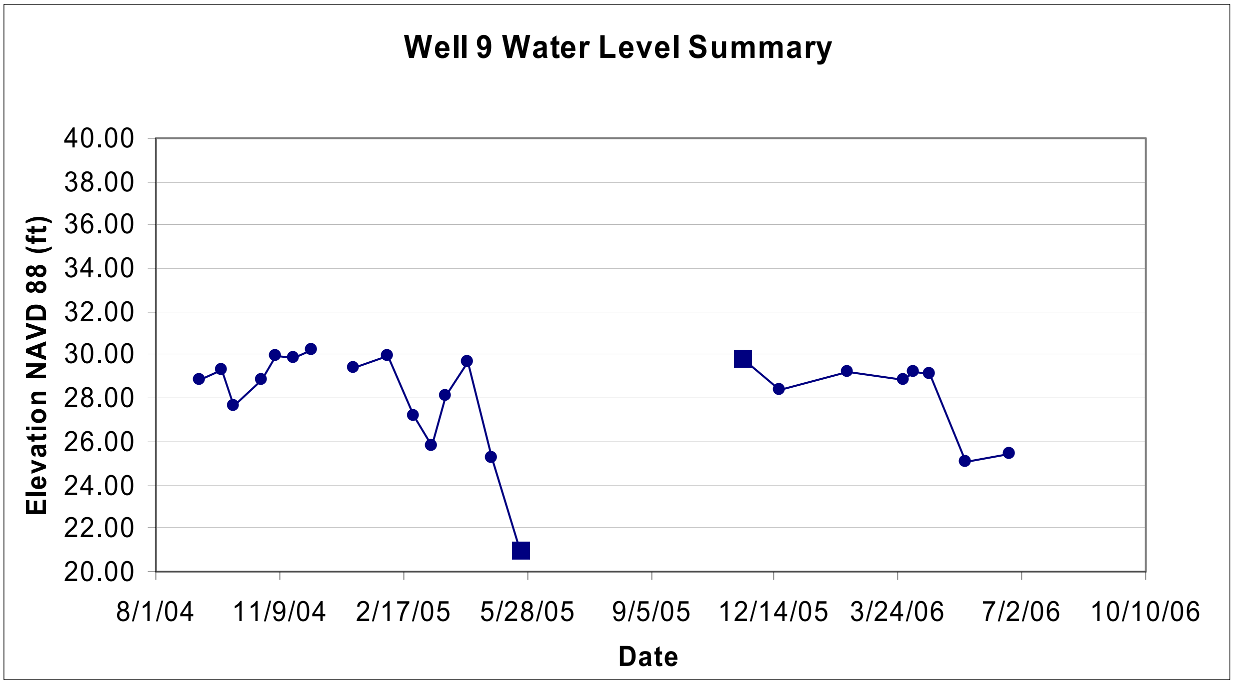



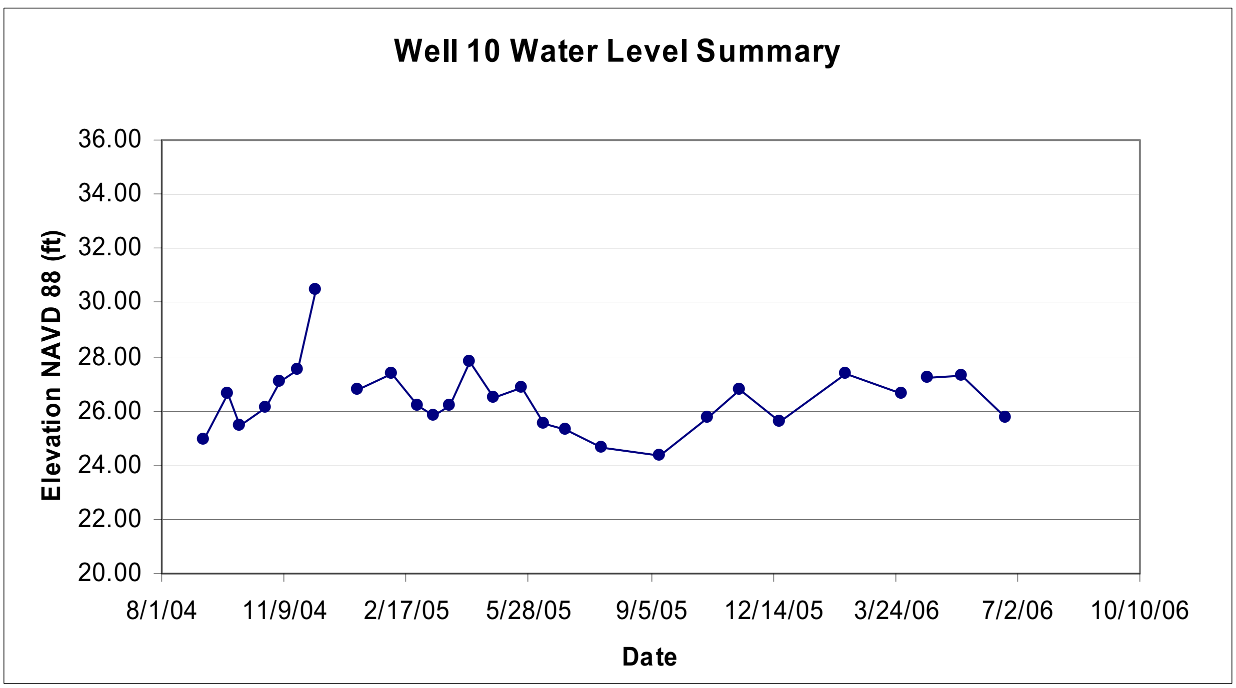

Denotes a period where the well was dry



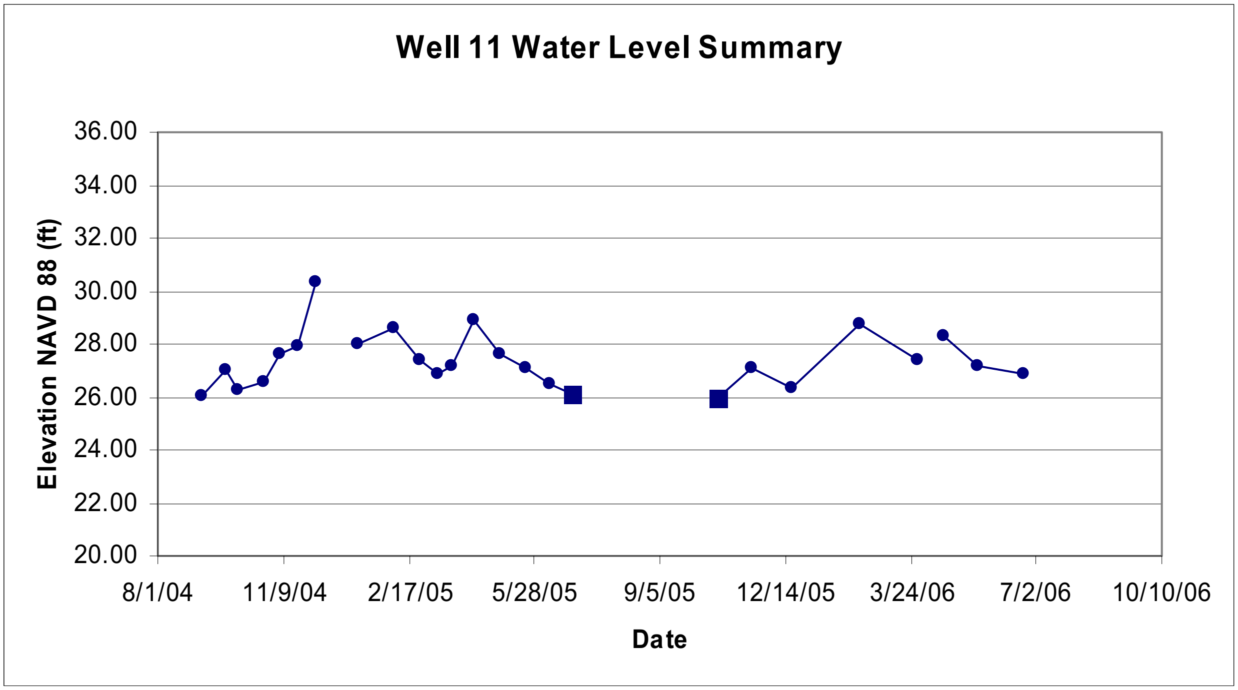



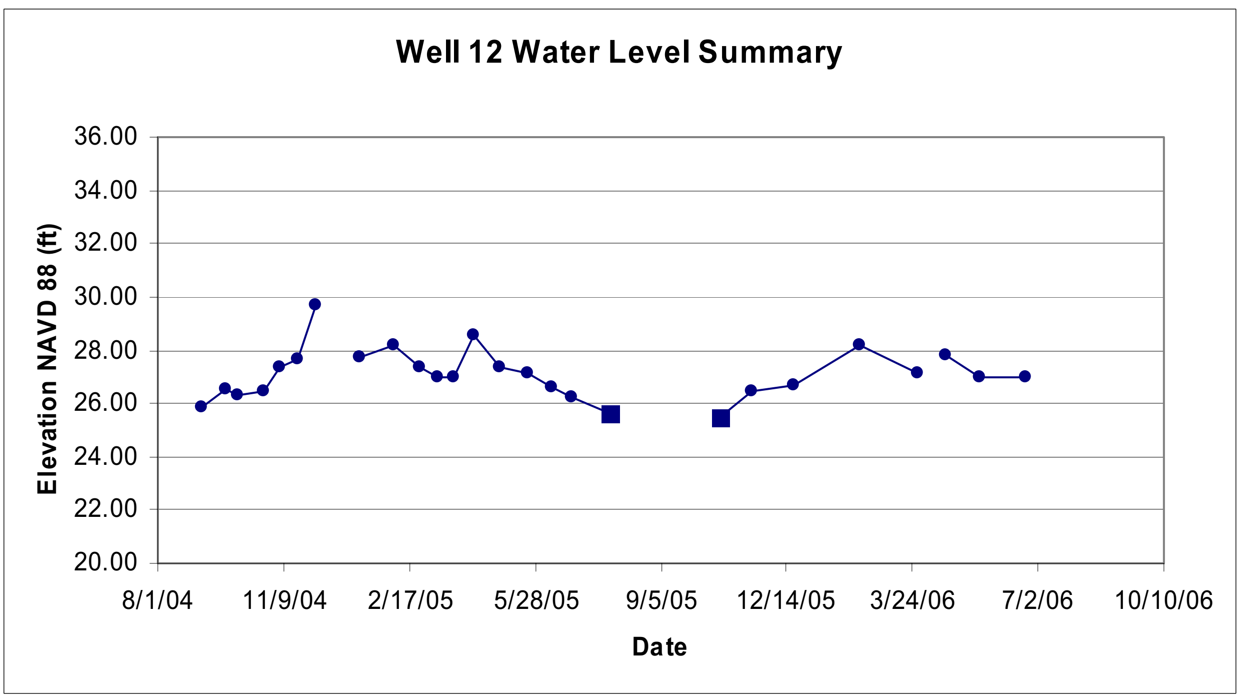

Denotes a period where the well was dry



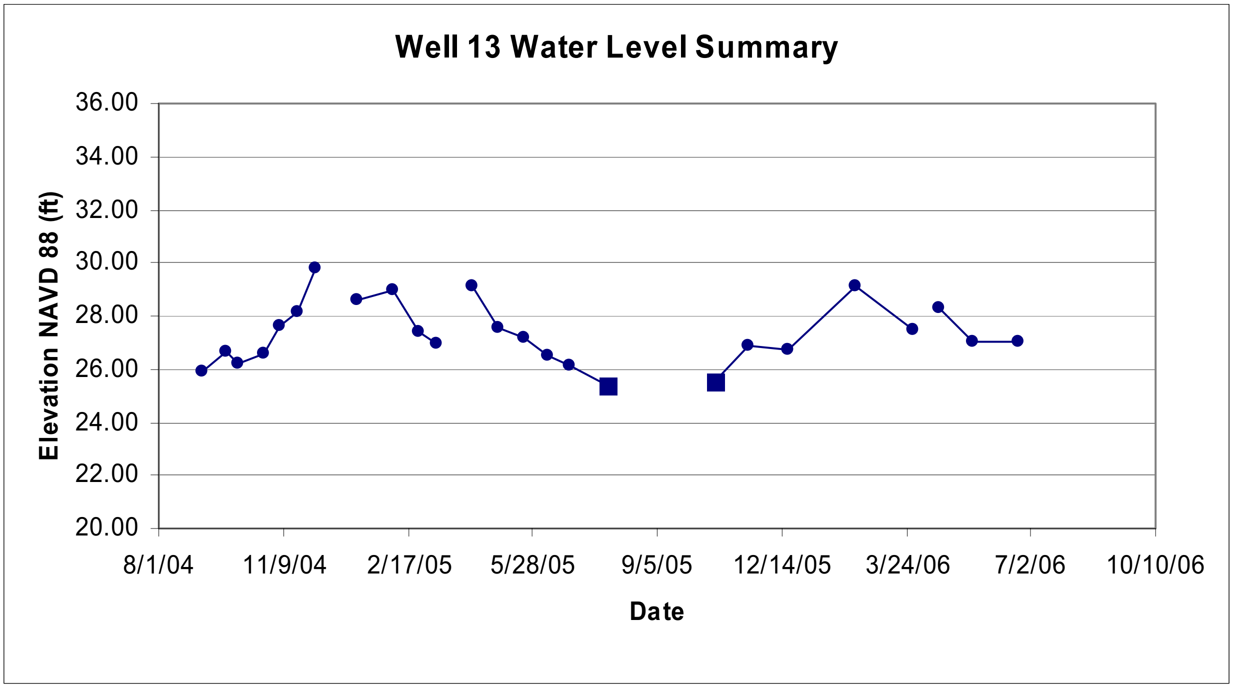



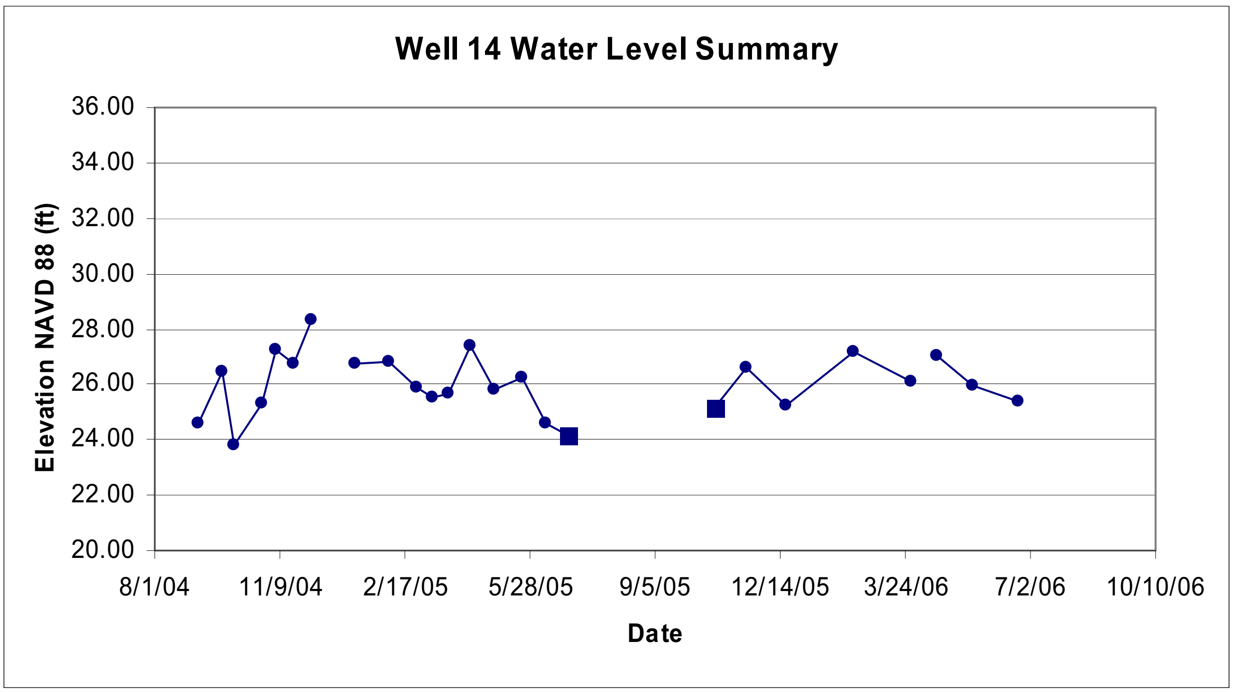

Denotes a period where the well was dry



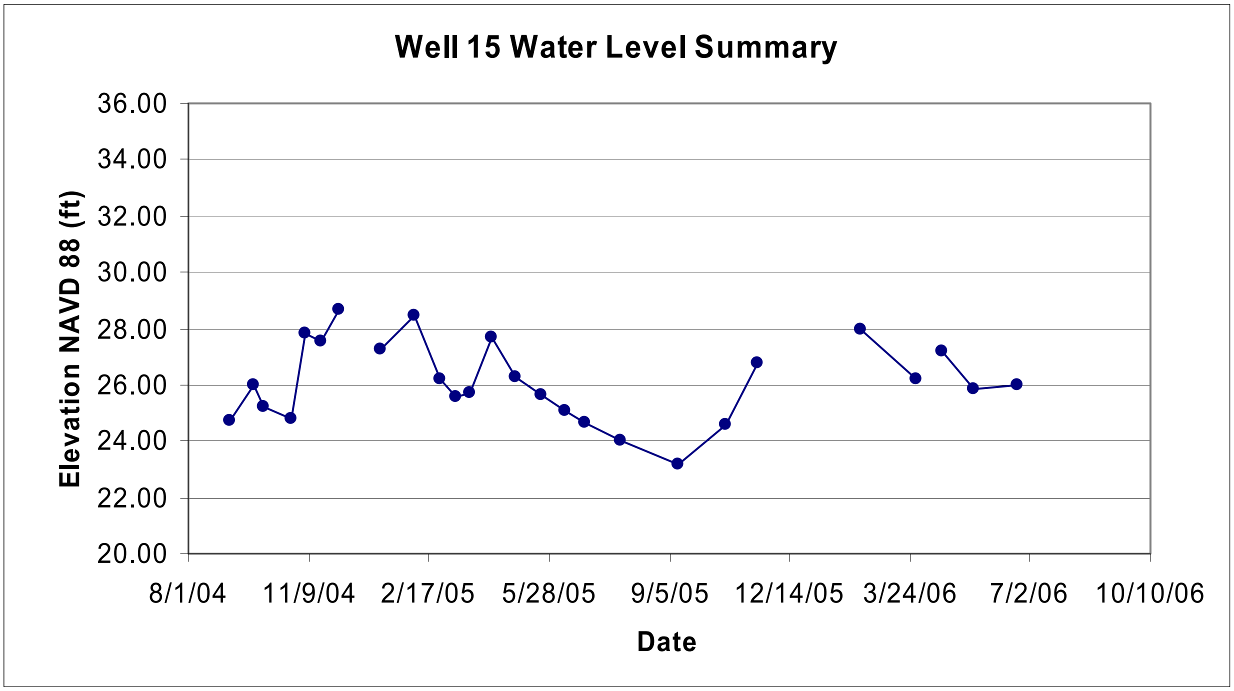



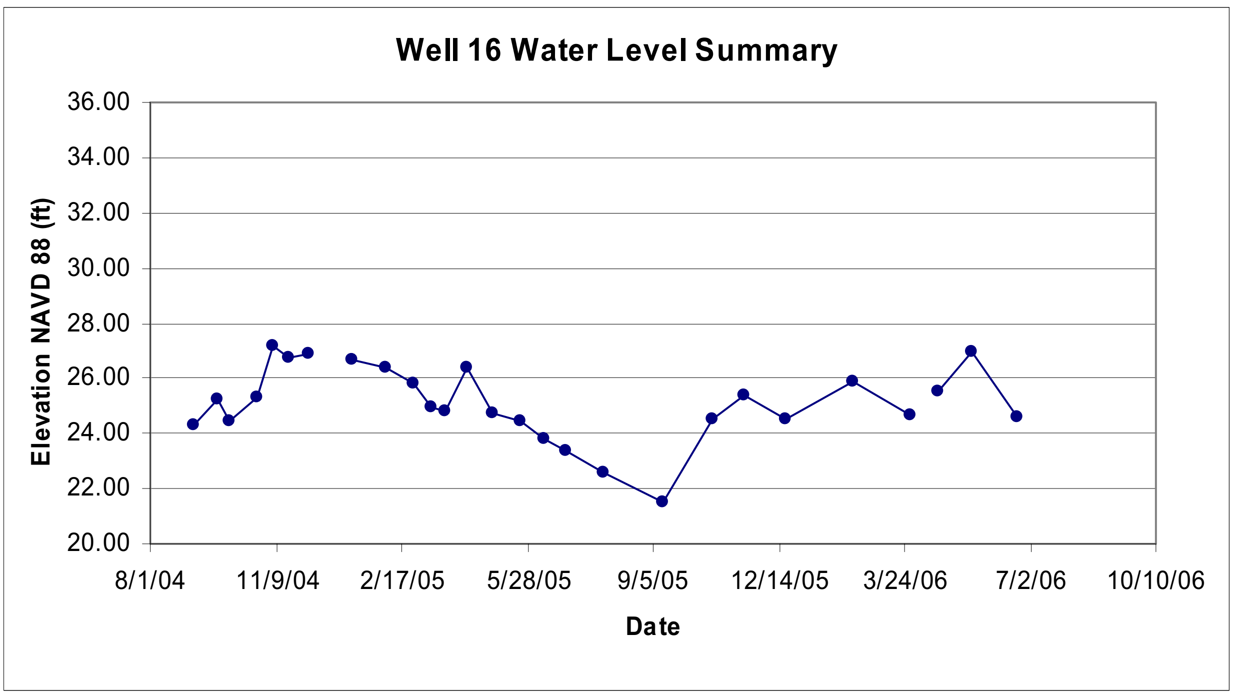

■ Denotes a period where the well was dry



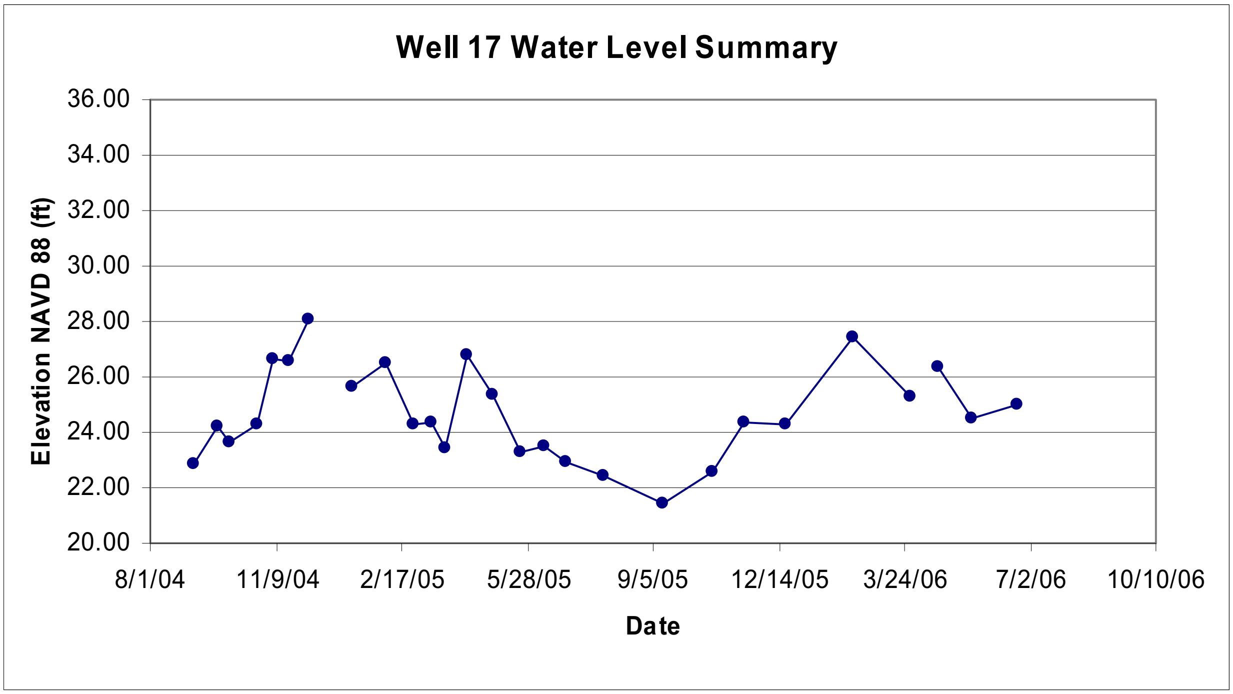



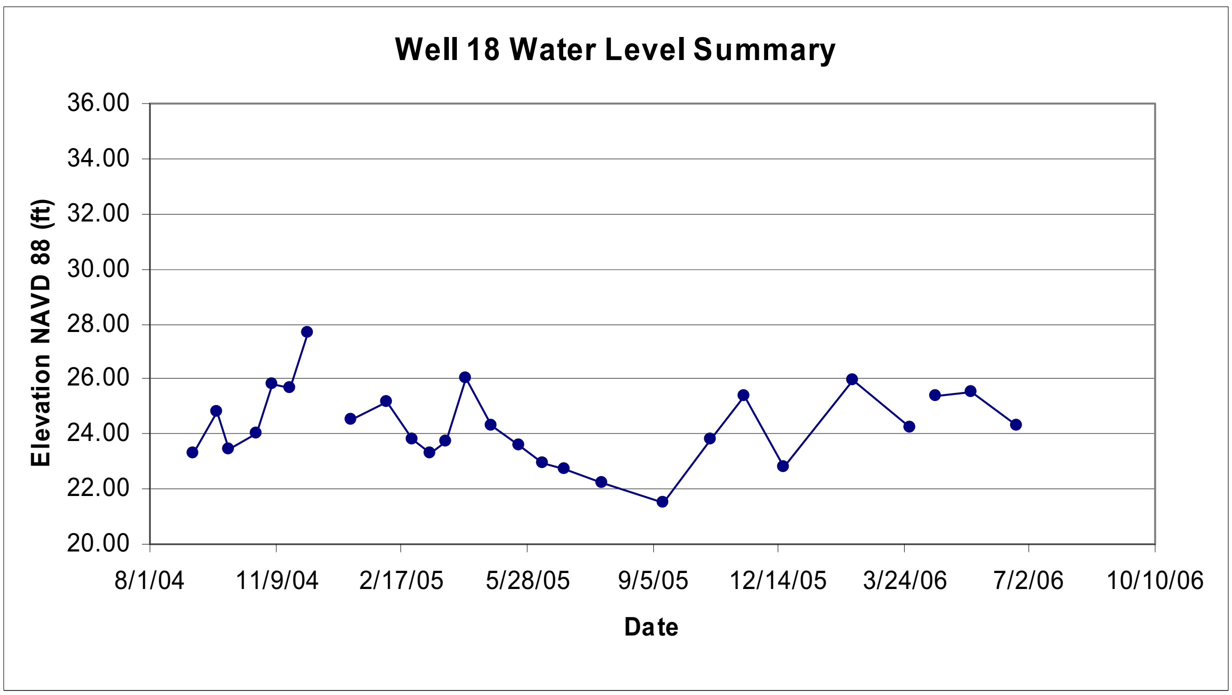

Denotes a period where the well was dry



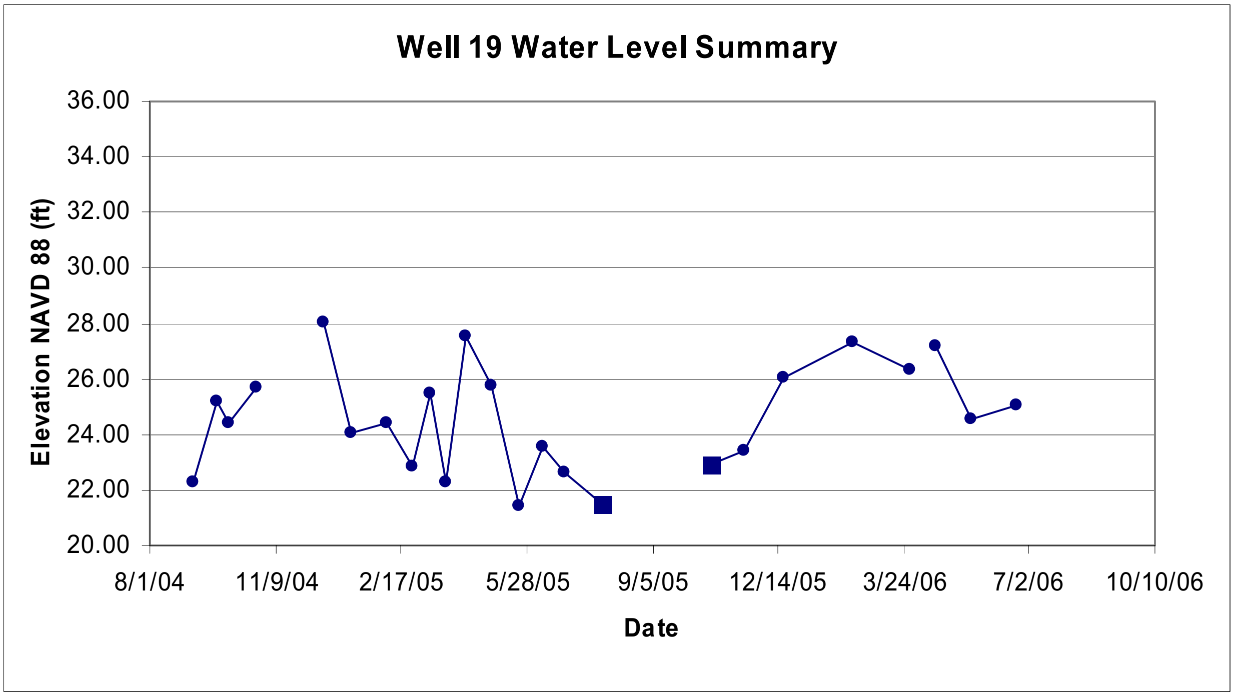



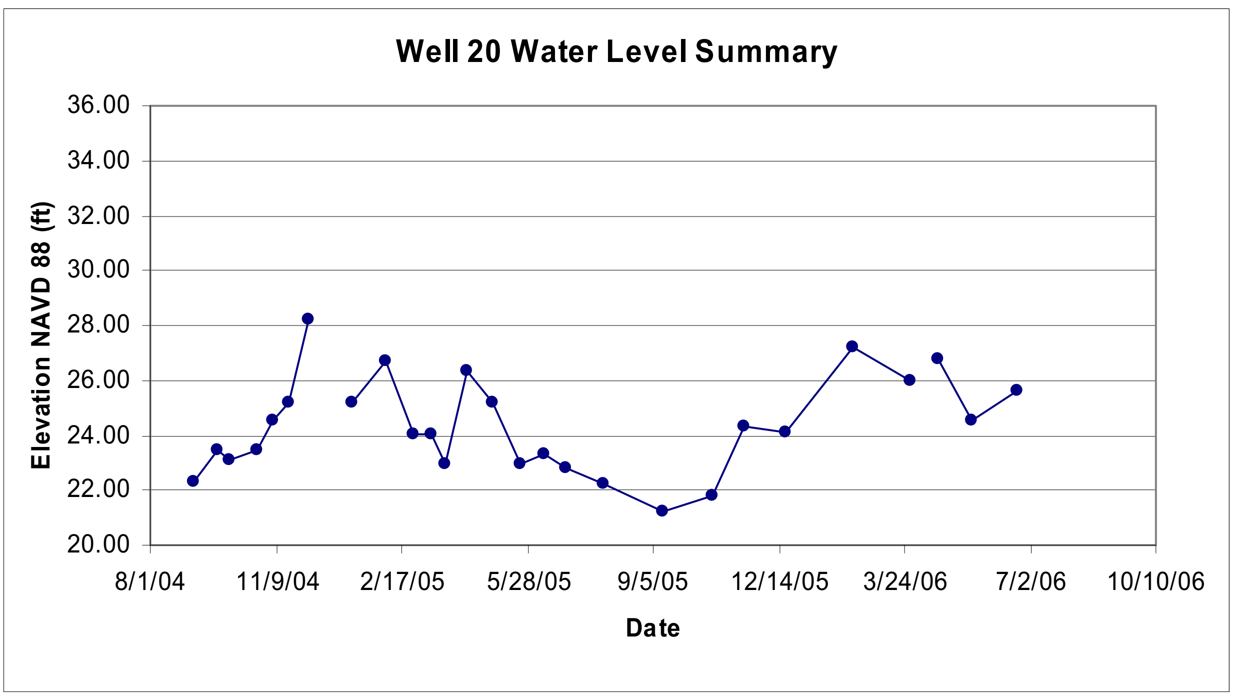

Denotes a period where the well was dry

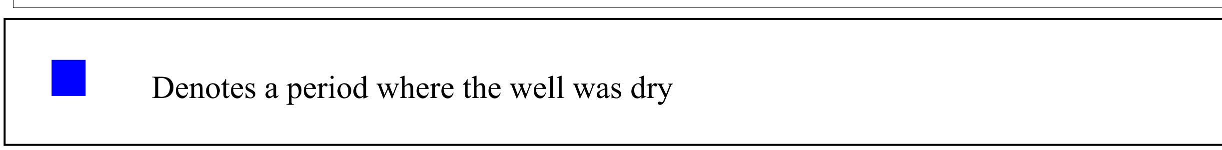


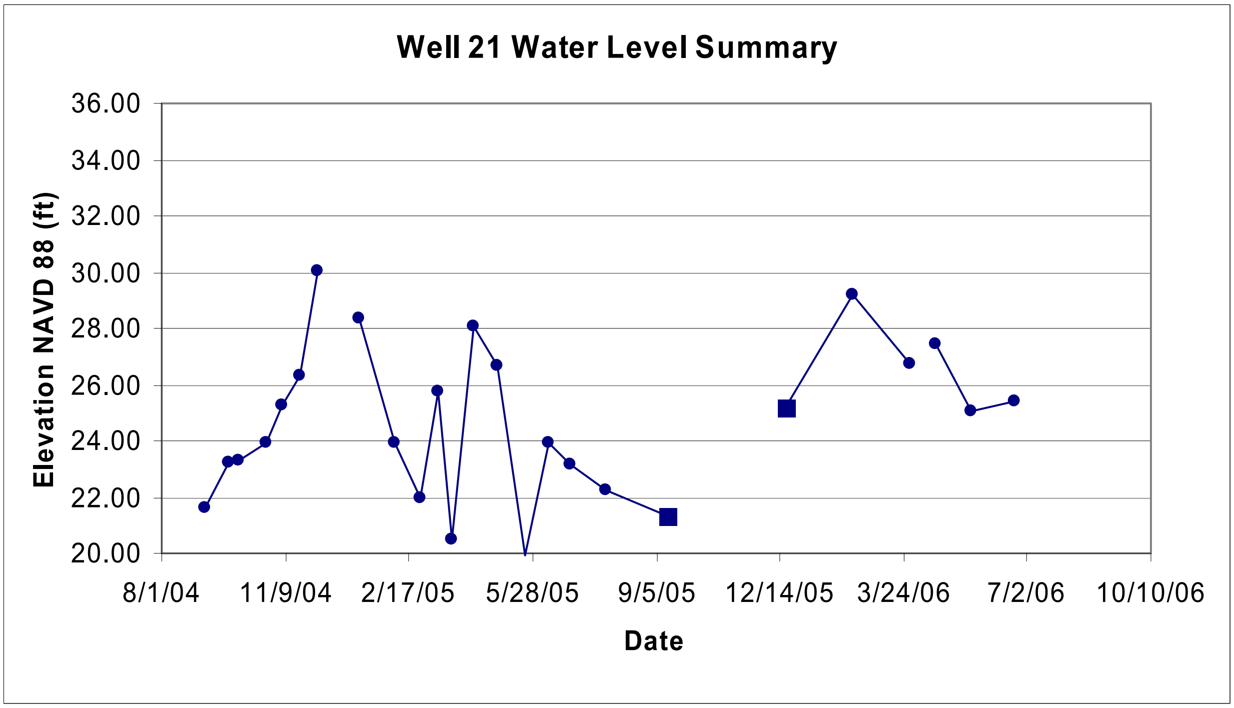



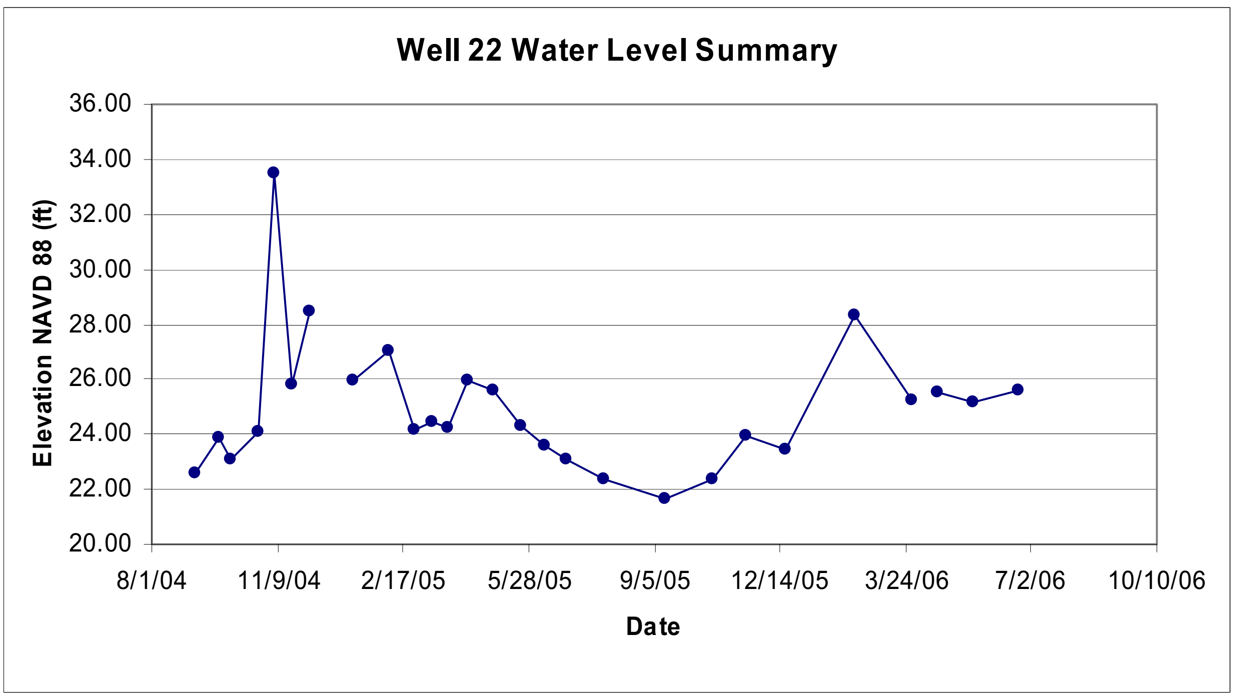

Denotes a period where the well was dry


Well 19 Water Level Summary
Elevation NAVD 88 (ft)
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
11/9/04
2/17/05
5/28/05
9/5/05
12/14/05
3/24/06
7/2/06
10/10/06
Date

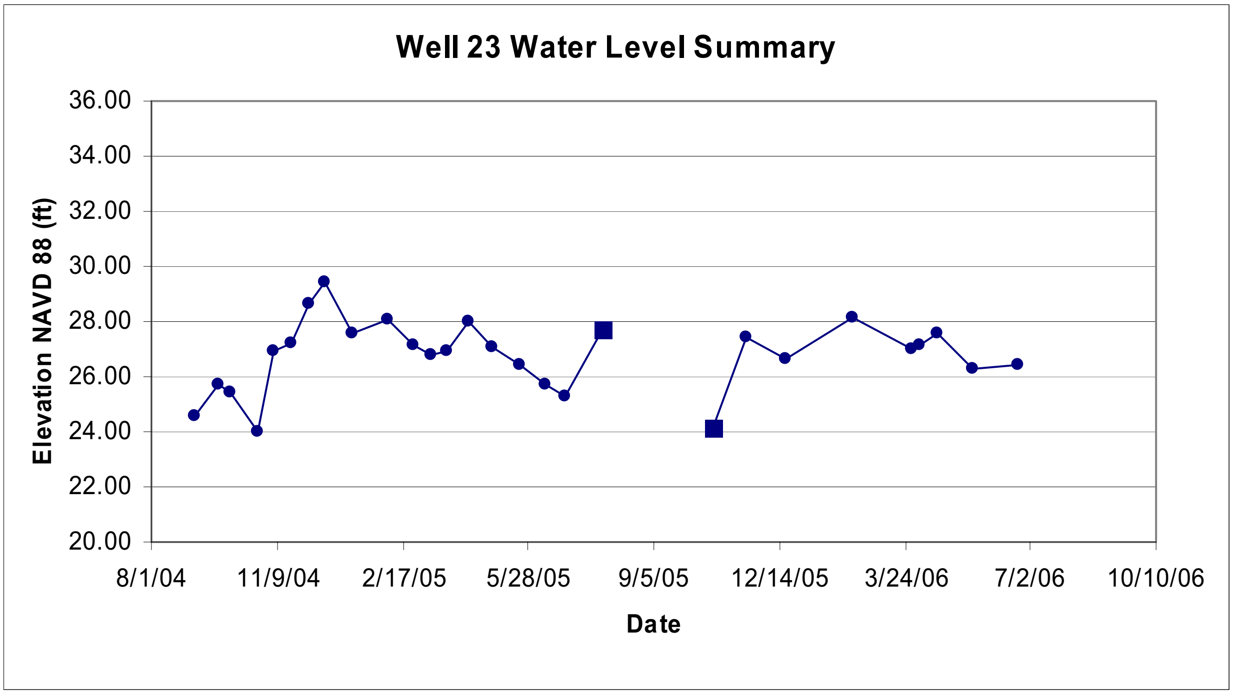

Well 20 Water Level Summary
Elevation NAVD 88 (ft)
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
11/9/04
2/17/05
5/28/05
9/5/05
12/14/05
3/24/06
7/2/06
10/10/06
Date

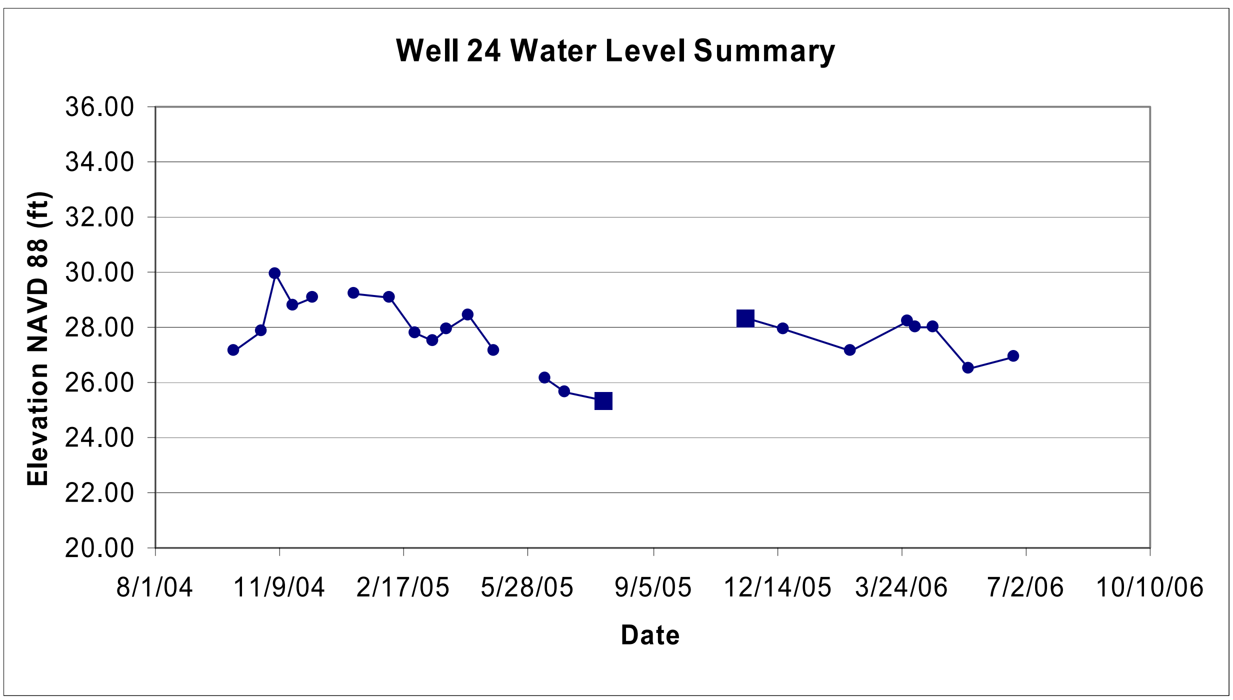

Denotes a period where the well was dry



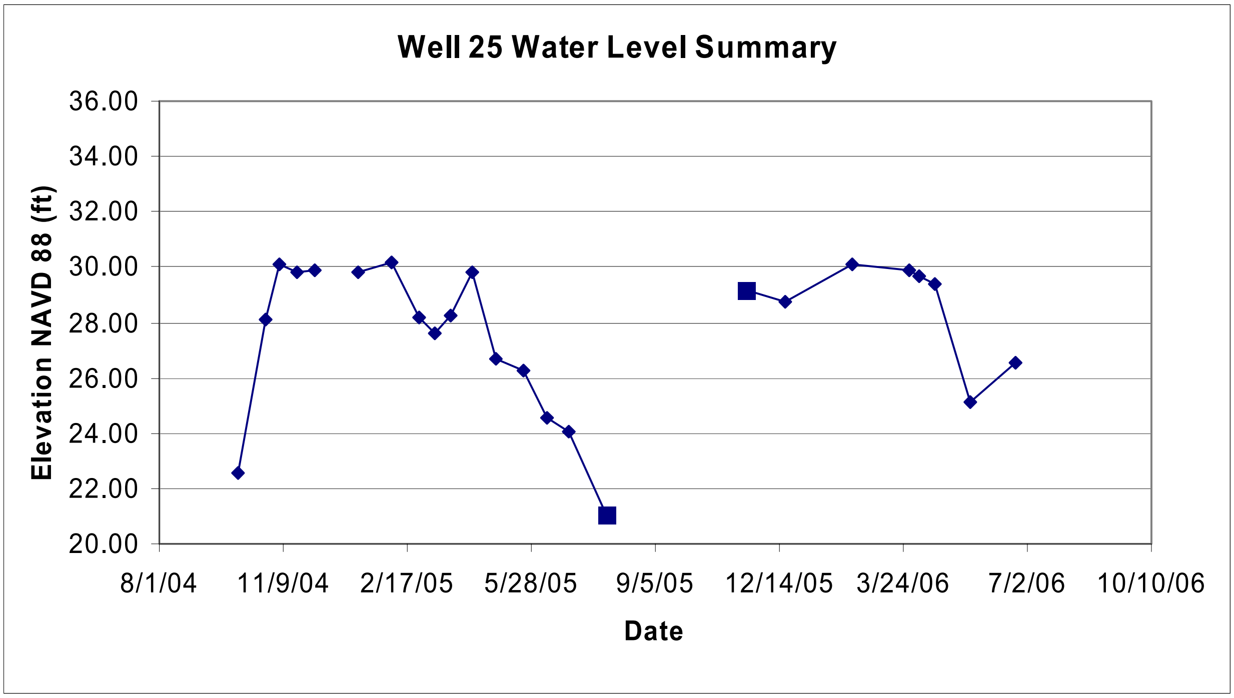



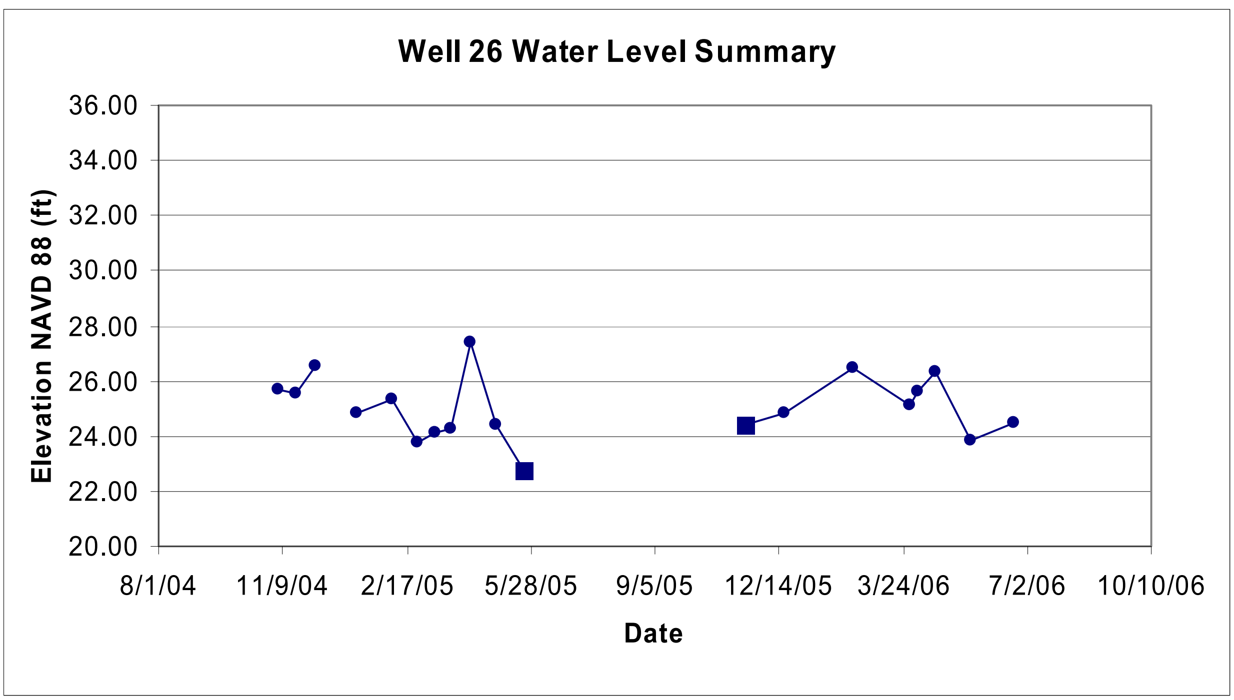

■ Denotes a period where the well was dry



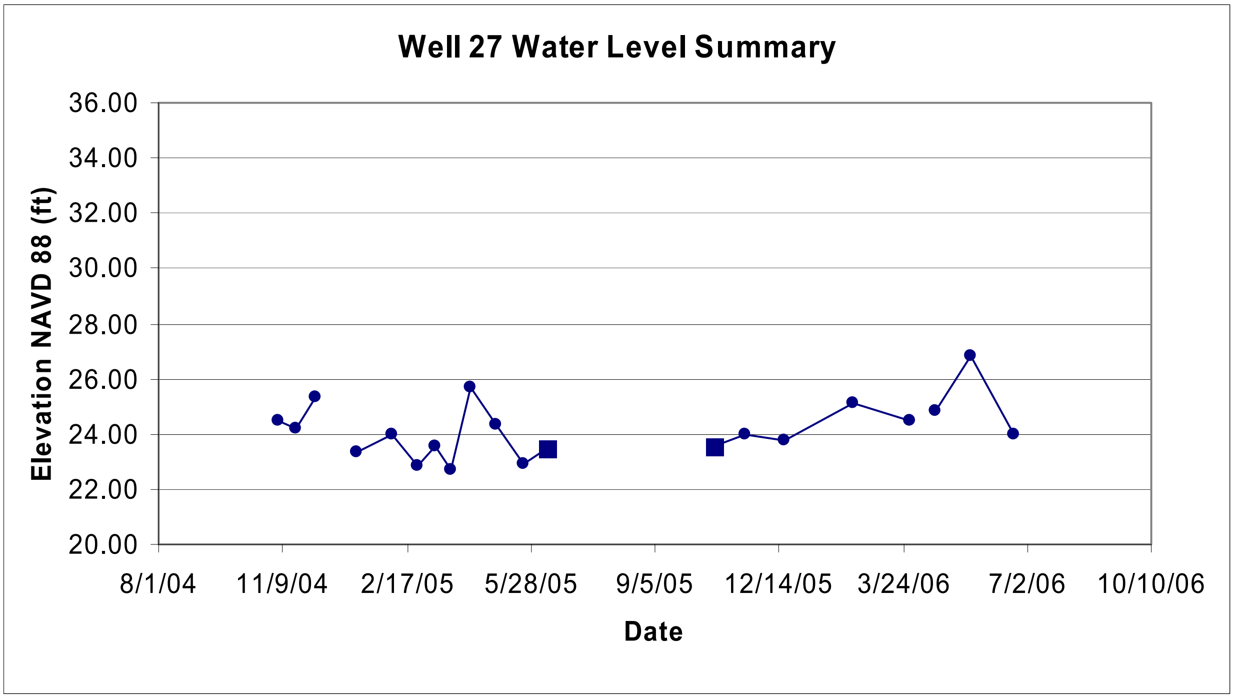



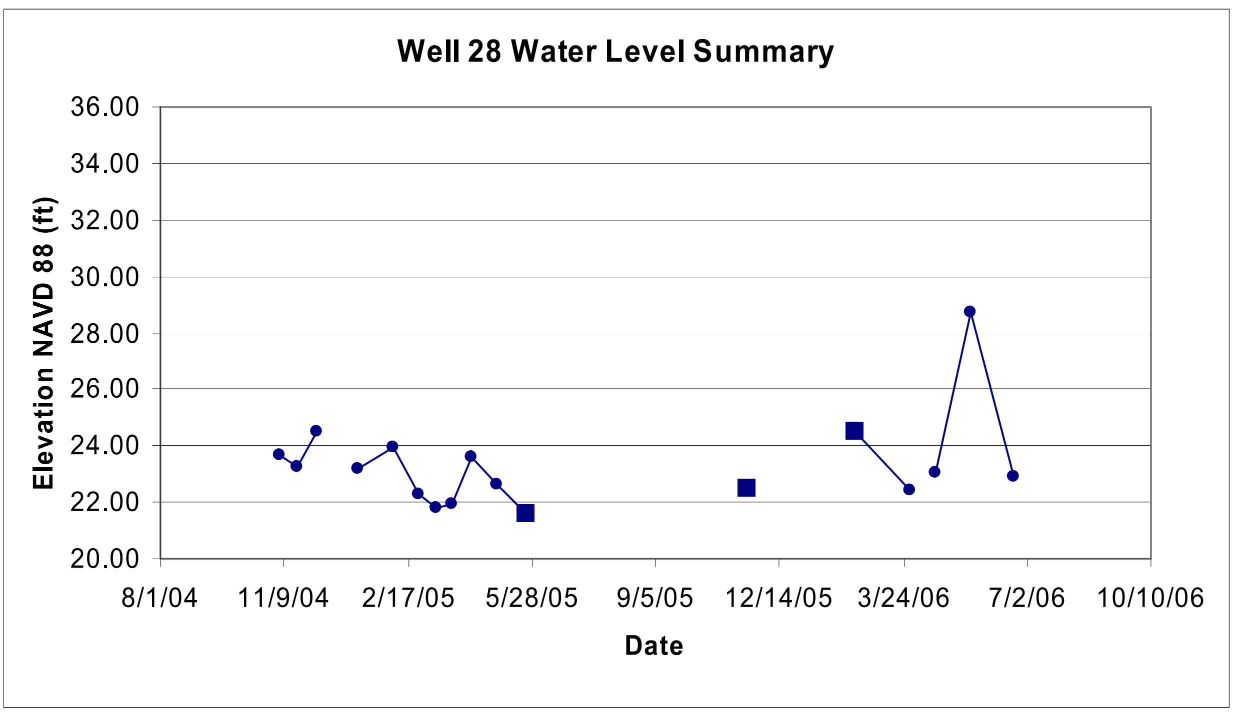

■ Denotes a period where the well was dry



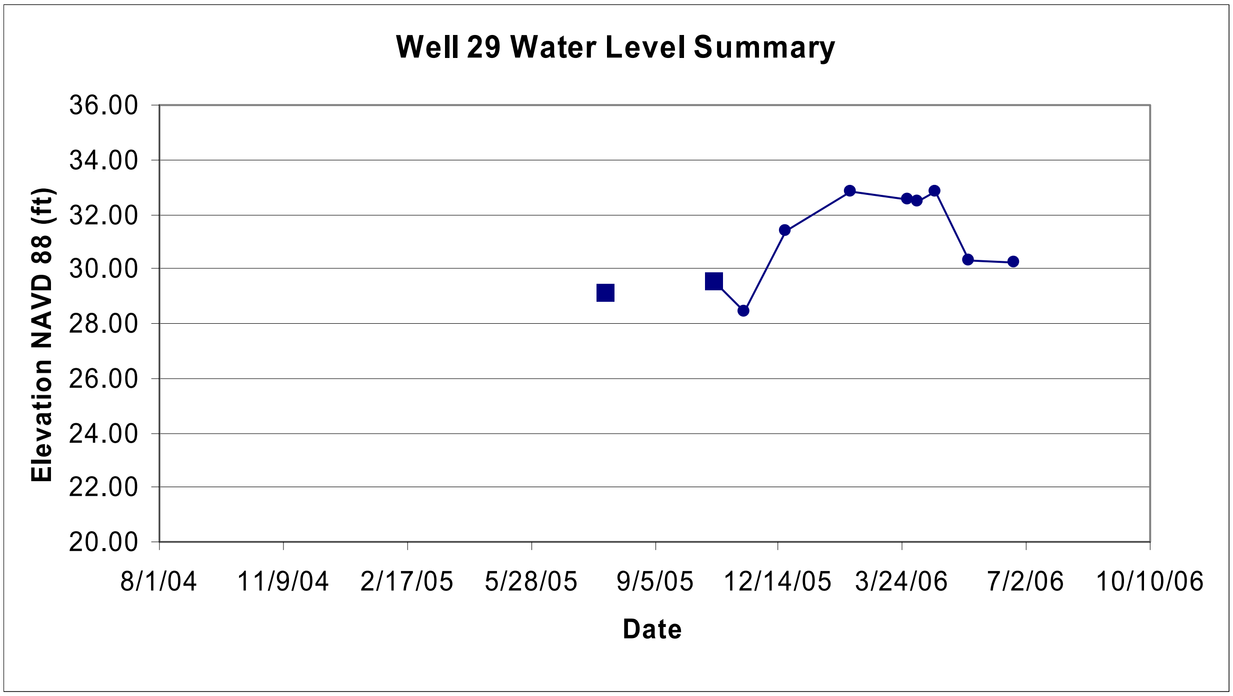



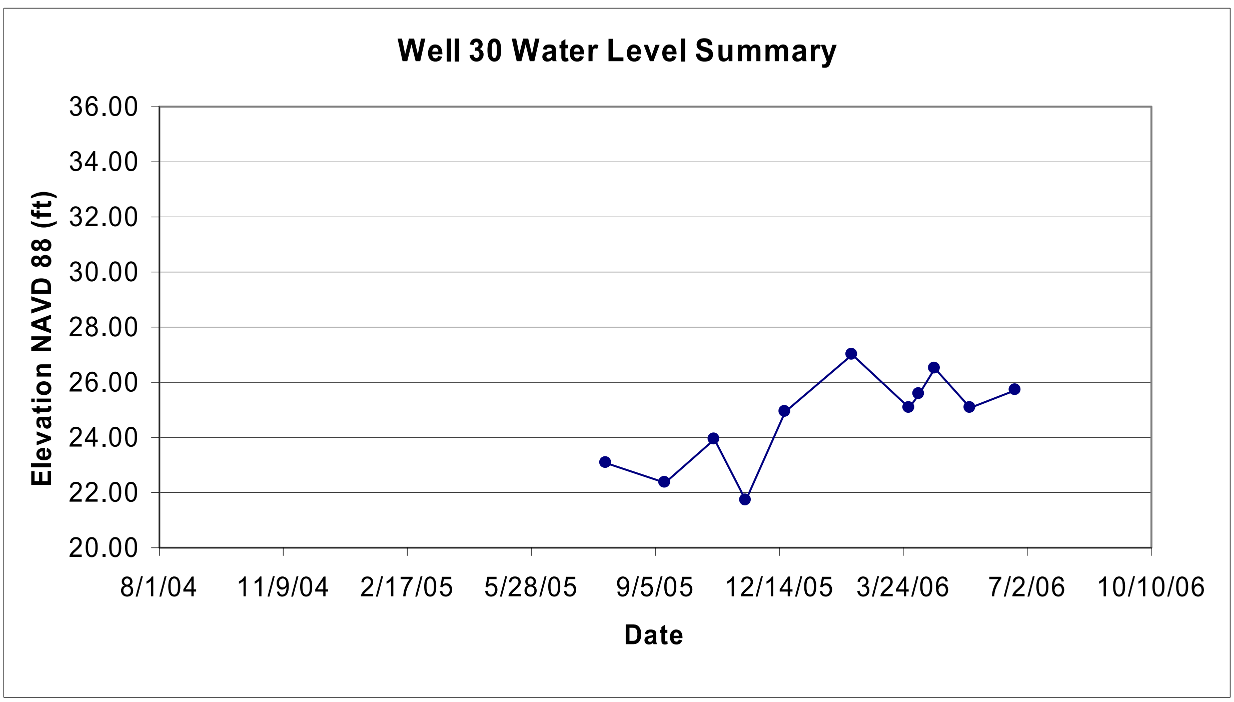

Denotes a period where the well was dry



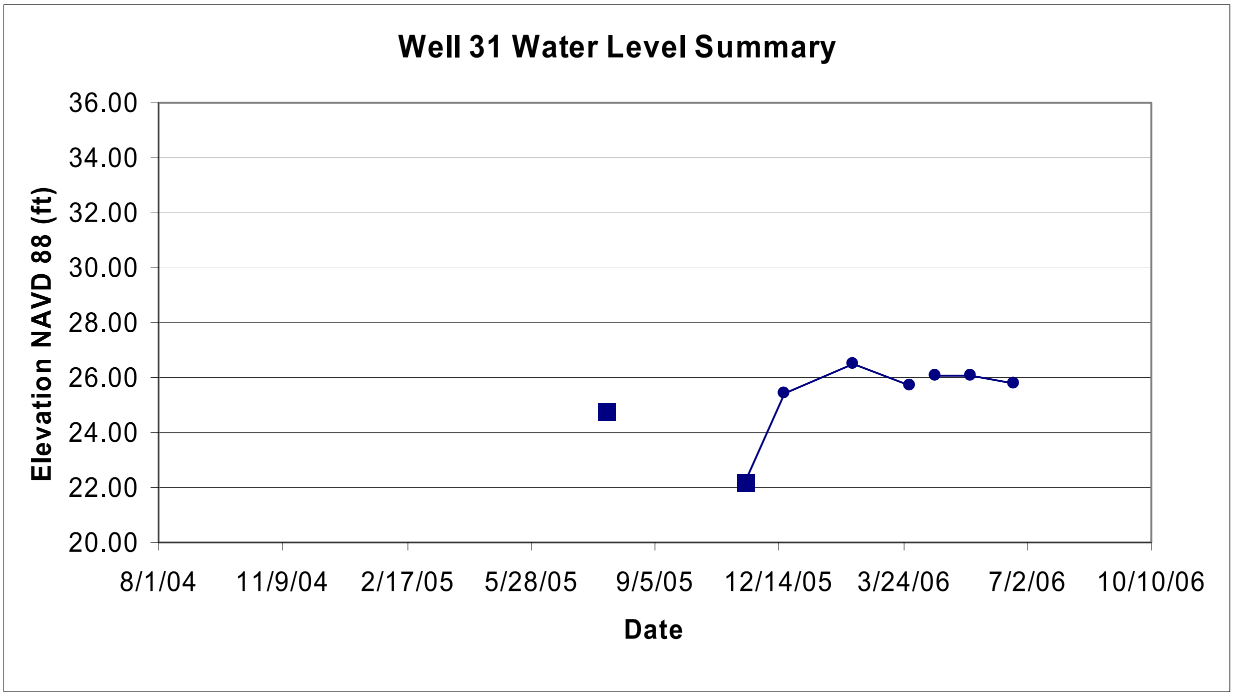



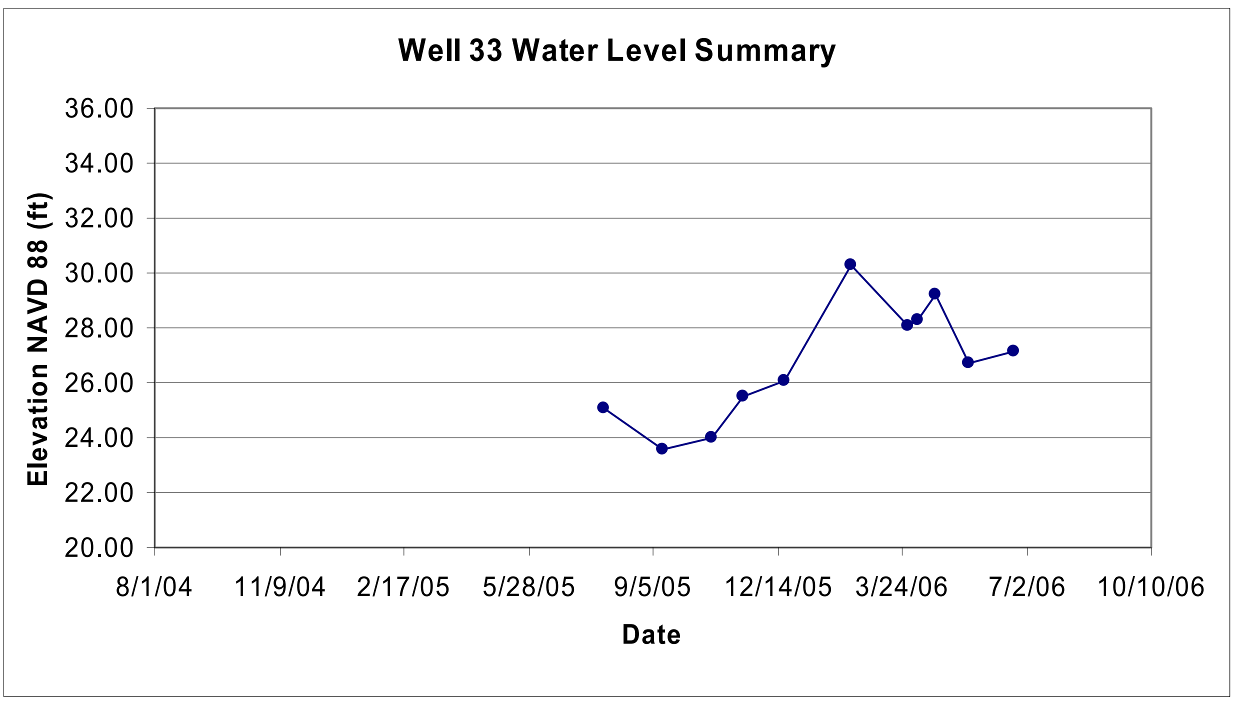

■ Denotes a period where the well was dry



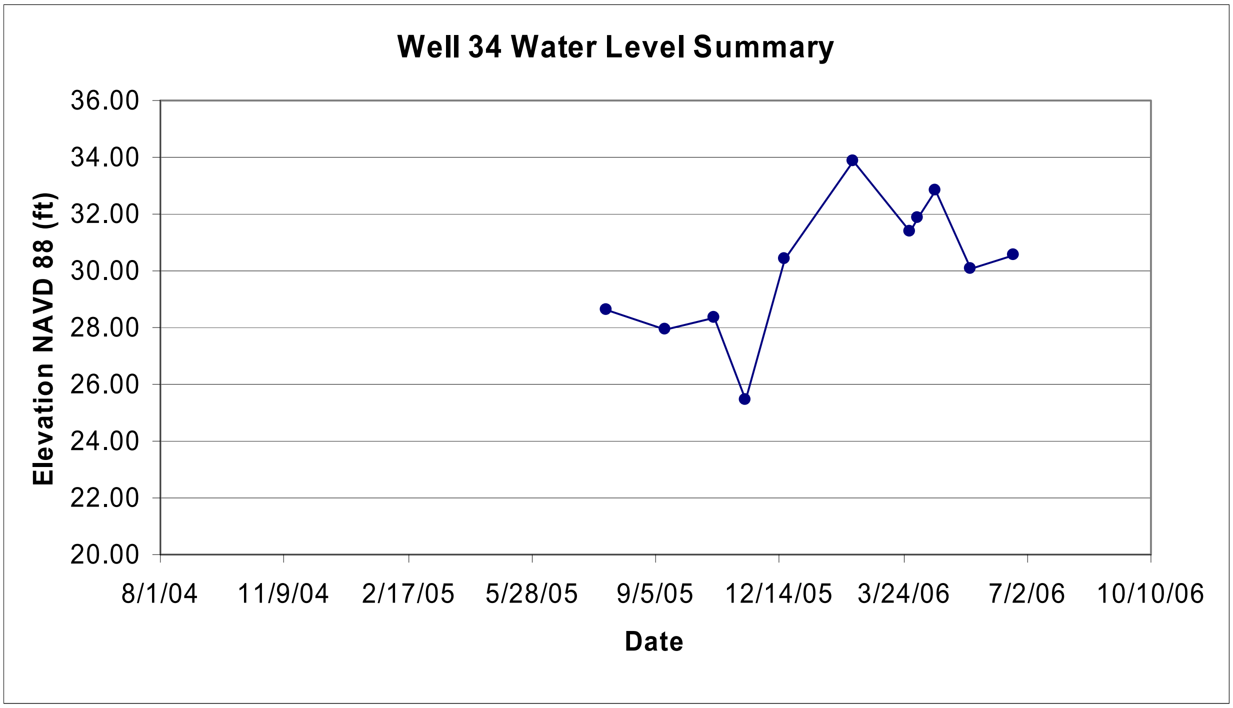




| | |
|---|---|
| ■ | Denotes a period where the well was dry |

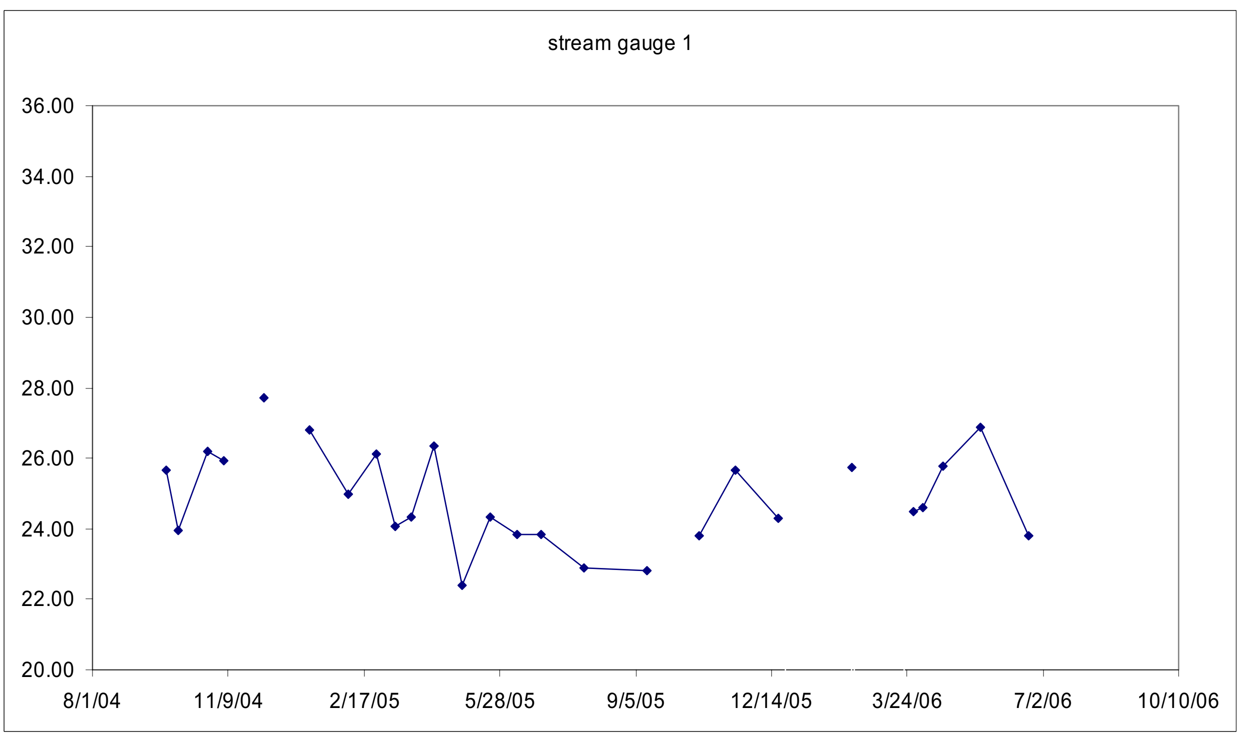


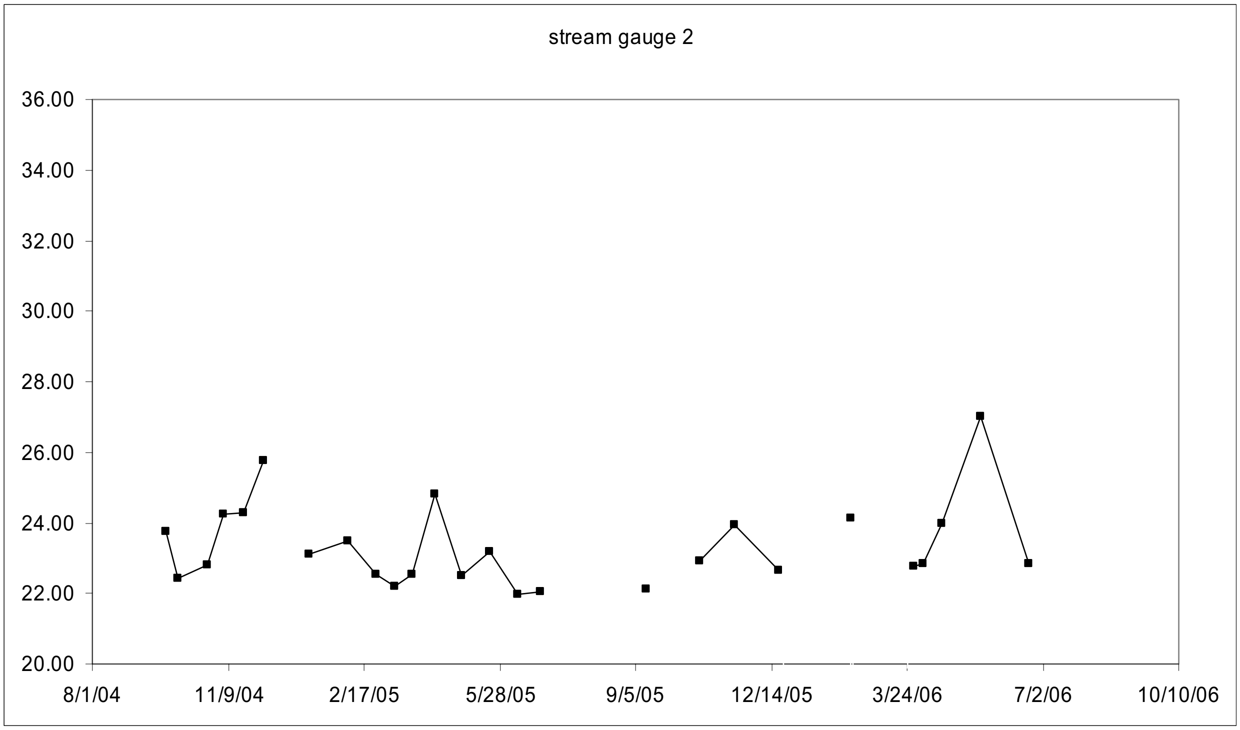




| | |
|---|---|
| ■ | Denotes a period where the well was dry |




Denotes a period where the well was dry




stream gauge 2
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
11/9/04
2/17/05
5/28/05
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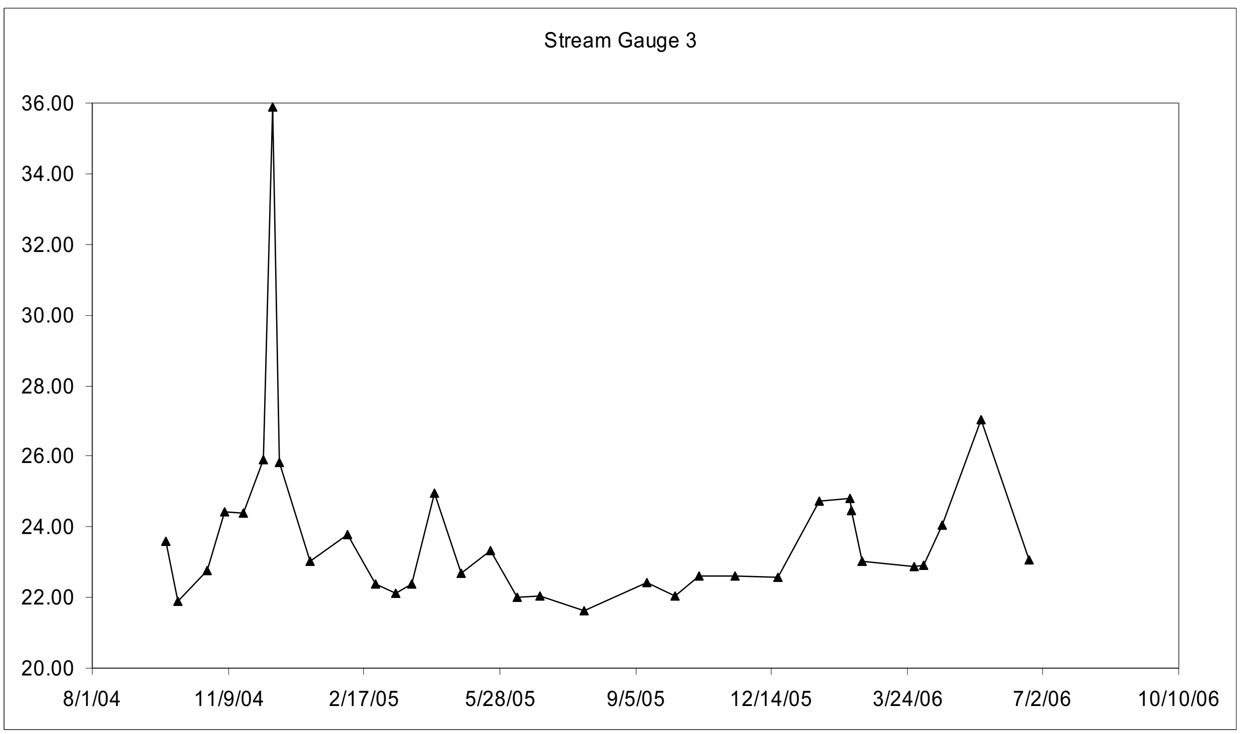
3/24/06
7/2/06
10/10/06


Stream Gauge 3
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
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2/17/05
5/28/05
9/5/05
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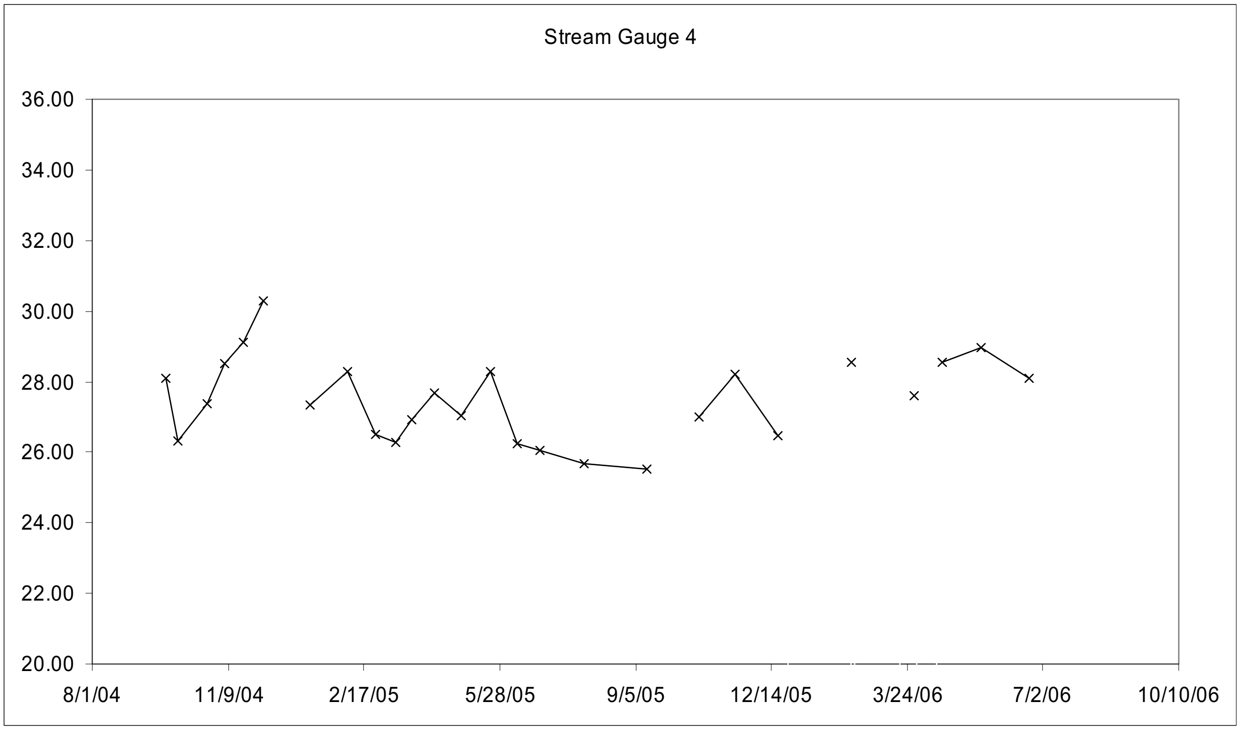
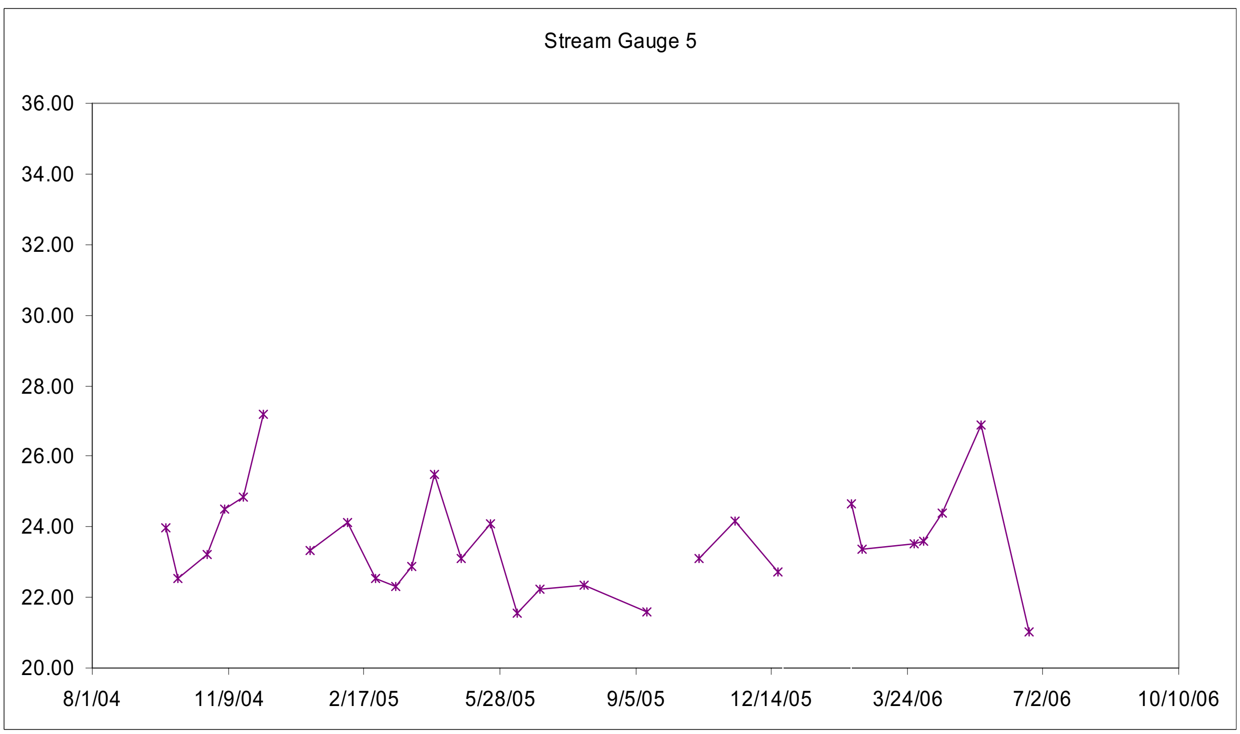
3/24/06
7/2/06
10/10/06


Stream Gauge 4
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
11/9/04
2/17/05
5/28/05
9/5/05
12/14/05
3/24/06
7/2/06
10/10/06


Stream Gauge 5
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
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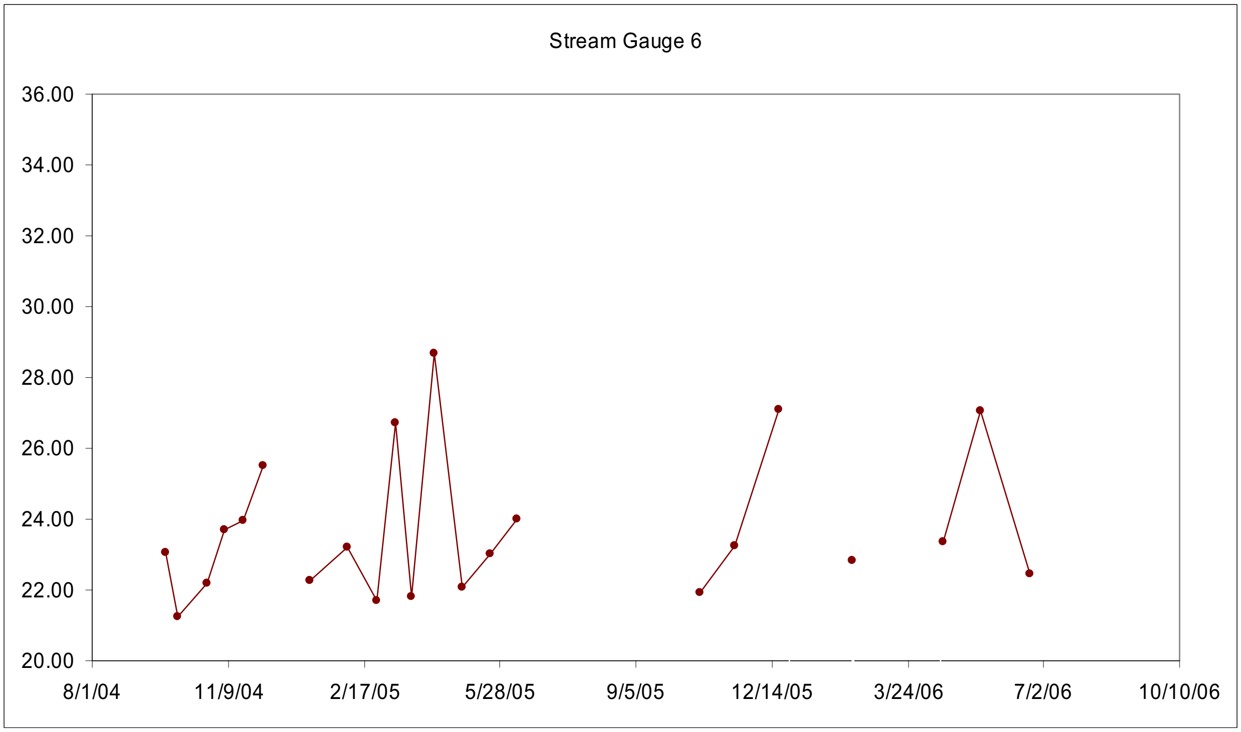
3/24/06
7/2/06
10/10/06


Stream Gauge 6
36.00
34.00
32.00
30.00
28.00
26.00
24.00
22.00
20.00
8/1/04
11/9/04
2/17/05
5/28/05
9/5/05
12/14/05
3/24/06
7/2/06
10/10/06