HANSEN CREEK: REACH 2 RESTORATION AND SEDIMENT RETENTION PROJECT REPORT SKAGIT COUNTY, WASHINGTON

JULY 30, 2004

FOR
SKAGIT COUNTY PUBLIC WORKS

GeoEngineers

File No. 0220-072-00

GeoEngineers

July 30, 2004

Skagit County Public Works
1800 Continental Pl
Mt. Vernon, WA 98273-5625

Attention: Derek Koellmann

Subject: Report
Hansen Creek: Reach 2 Restoration
and Sediment Retention Project
File No. 0220-072-00

HANSEN CREEK: REACH 2 RESTORATION AND SEDIMENT RETENTION PROJECT

Hansen Creek is located east of the town of Sedro Woolley in Skagit County and is a tributary to the Skagit River (Figure 1). The headwaters are sediment rich first order streams that drain Lyman Hill. Historically these sediments were transported and deposited in areas that have now been converted for agricultural or residential use. To counteract flooding and sedimentation in these areas, humans have diked and dredged the stream which has resulted in channelization, and a disconnection between creek and its floodplain. The Hansen Creek Watershed Management Plan outlined these issues as well as delineated reaches and targeted areas for restoration (Miller Consulting, 2002).

This project presents restoration strategies for "Reach 2" of Hansen Creek as delineated in the Hansen Creek Watershed Management Plan. Reach 2 is directly below an instream sediment pond established to remove sediment transported from the headwaters. The sediment pond has been mined as needed since its inception. As a result, Reach 2 has been sediment starved and has incised. Additional dredging of the downstream reach has further promoted incision. These actions have resulted in a disconnect of the creek from its historic floodplain reducing off channel habitat and exacerbating flood peaks downstream in residential and agricultural areas.

Project Objective

The overall objective of this project is to retain sediment and raise the bed of the stream in order to reconnect it with its floodplain and provide channel complexity to improve habitat for fish species residing in and migrating through the stream. Raising the bed and reconnecting the stream to its floodplain will result in water storage during floods potentially reducing flood peaks downstream. The floodplain may also act to store smaller woody debris and sediment that would otherwise be transported downstream.

The implementation strategy will involve placing large woody debris (LWD) in the form of discrete structures throughout Reach 2 in strategic locations. These structures are designed to promote physical and hydraulic modifications of the stream and its channel in order to achieve the desired goals. Placement of wood into rivers introduces large roughness elements that in turn induce changes in local hydraulics. The structural complexity of a LWD accumulation provides cover and feeding habitat for a large variety

600 Dupont Street
Bellingham, WA 98225
telephone 360.647.1510
facsimile 360.647.5044
website www.geoengineers.com

of juvenile fishes, while the hydraulic variability provides a quiescent zone preferred by adults for holding in close proximity to ample sources of drifting food organisms.

Each structure is designed specifically for its location and will incorporate existing wood in the system as much as possible. Because many of these structures will span the creek channel, hydraulic forces acting on them will be high. Typically, instream structures are most vonerable to failure during the initial peak flows after construction. Once the stream channel has adjusted to the feature hydraulic forces are redistributed and the likelihood of failure is reduced. Therefore structures must be stable enough to withstand the hydraulic forces acting upon them as the creek adjusts to the new configurations. To promote stability of the structures, log members will be tied together with 1 inch biodegradable rope at locations where structural members meet. The rope will disintegrate within several years of exposure, but will have promoted stable conditions during the creeks adjustment to the proposed features.

REACH SCALE STRATEGIES

Based upon characteristics of the channel, floodplains, terraces, and project objectives we divided Reach 2 into two segments. Segment 1 is the lower portion of the reach extending from the lower bridge, station 0+00, up to station 12+03; Segment 2 is the upper portion of the reach extending from station 12+03 to the outlet to the sediment pond at station 18+62 (Figure 2).

Figure 2 illustrates the areas and depths of inundation of floodplain areas during high flows. It is shown in Figure 2 that Segment 1 has greater floodplain connectivity than Segment 2. This is because of the presence of higher cut banks and floodplains relative to the channel in Segment 2. Therefore a greater disconnect between the stream and floodplain exists in Segment 2. What this means from a practical standpoint is that the likelihood of inducing improved floodplain connectivity is much greater in Segment 1 than Segment 2. Hence we propose to target improved floodplain connectivity in Segment 1 while encourage channel migration and the creation of new floodplain areas in Segment 2.

Structures placed in Segment 1 will induce backwater conditions and target retaining woody debris and sediment and will also act to split and diversify flow. Our approach is aggressive in this section with the placement of large complex structures. We expect that this approach will be successful in retaining the majority of woody debris delivered to the reach. This will progressively jam up the channel and begin retaining sediments and raising the bed elevation.

Segment 2 is fairly straight with little variation in instream hydraulics. Structures placed in this section will focus on diversifying flow, increasing sinuosity and promoting channel migration. These actions will promote the recruitment of sediment from the local banks making it available for storage in and adjacent to our proposed structures in both segments. The combination of sediment recruitment and retention will promote a rise in stream bed elevation thereby promoting increased floodplain connectivity.

ARCHITECTURE AND NOMENCLATURE FOR THE ENGINEERED LARGE WOODY DEBRIS STRUCTURES

Structures placed in the stream will consist primarily of large woody debris. These features are designed to promote channel migration, channel complexity, create secondary flow paths and retain woody debris and sediment. These large woody debris structures are self sustainable habitat features that create preferred holding and spawning habitat for salmonids while promoting the desired physical and hydraulic changes to the system.

The types of structures that will be constructed include engineered log jams, large woody debris accumulations, and both small and large scale channel spanning obstructions. The locations of the proposed structures are shown in Figures 3 and 4. For purposes of clarity and monitoring, each placement was given a unique identifier. The identifier will begin with an H representing the "Hansen Creek" project. Next will be a number representing each jam's relative position within the project. This will be followed by an identifier representing the structure type such as;

- A – Accumulation of Large Woody Debris
- RT – Channel spanning structure along right side of the thalweg
- LT – Channel spanning structure along left side of the thalweg
- RB – Channel spanning structure at a right turning meander bend
- LB – Channel spanning structure at a left turning meander bend
- CTR – Structure spans ½ the channel and is tied into right bank
- CTL – Structure spans ½ the channel and is tied into left bank
- CR – Crib Jam: Channel spanning obstruction similar in structure to a log cribwall
- LJ – Engineered Log Jam (ELJ)

The final number will represent the total number of logs within the structure. Therefore an example identifier might be H6-LJ27.

STRUCTURE LOCATIONS AND OBJECTIVES

This section describes the locations, structures, and intended objectives of each structure. Most of the structures proposed for this project are channel spanning obstructions designed to promote wood and sediment retention. Identifiers are sequenced moving upstream.

H1-A15
This structure is located at station 1+00, upstream of the lower bridge in Segment 1. This site is a meander bend traversing to the left with a 7 foot high cutbank on the right and 1-2 foot high floodplain in the left. The structure proposed for this site is an accumulation of LWD that emulates debris jams found on the outside of meander bends in natural systems. The intention of this structure is to protect the cut bank at this location from accelerated erosion and impede downstream migration of the meander bend. Downstream migration of this particular meander bend, if allowed to continue unchecked, poses a threat to the bridge and local access road.

H2-RT3
This is a channel spanning obstruction located at station 1+45. This is a straight section of stream with a 6 foot cutbank on the right and low floodplain on the left. The structure consists of one log placed parallel to the channel in the right side of the thalweg and two logs perpendicular to flow that help stabilize the first by anchoring them into opposite banks. This is designed to encourage dispersion of flow, pool formation and trapping of wood and sediment.

H3-LT3
This is structure is located station 1+99, in the same straight section of stream that structure H2-RT3 is placed. There are floodplains on both sides of the creek. This structure has the same basic elements, design and intended purpose as H2-RT3 although the longitudinal member in this structure will be placed on the left side of the active channel. Therefore a riffle will be formed between the two structures as the creek transitions from one pool to the other.

H4-RB4
This structure will be placed at station 2+77 within a right meander bend. A 6 foot high cut bank is located to the left and 3 foot high floodplain to the right. There is a deep pool near the left bank and a gravel bar along the right bank. Existing LWD buried in the left bank is incorporated into the design of these structures. This is a channel spanning obstruction with one log placed parallel to flow, two anchor logs and one that spans the channel on the upstream side. This structure is designed to promote channel migration to the east encouraging more flow to access the adjacent floodplain.

H5-CR8
This structure is located at station 3+79. The site is along a transition section between two meanders. There is a 3 foot floodplain on either side but just upstream the right bank transitions to a 7 foot cutbank and terrace. There is an accumulation of small woody debris upstream on the outside of the meander bend. This structure is a channel spanning structure with a unique architecture in that it forms a relatively square catch basin. This structure is designed to promote sediment and LWD retention and will likely collect all debris moving through the system to this point.

H6-LJ27
This structure will be placed at station 5+75 at the beginning of a left meander bend. An 8 foot cutbank exists on the right of the channel and 3 foot high floodplain on the left. The structure is an engineered log jam to be placed along the left edge of the channel with several logs spanning the channel and anchored into the right bank. This ELJ is designed to promote split flow conditions and promote pool development and channel complexity.

H7-LJ27
This structure will be an ELJ placed in a meander transition section of the creek at station 6+64. There is low bench on the right bank before it transitions to a terrace. There is a gravel side bar on the left and low floodplain beyond that. This ELJ will be placed in the gravel bar and is designed to backwater and promote deflection of flow toward the floodplain to the left. This will increase floodplain connectivity likely decreasing stream power in the mainstem and promoting aggradation in the mainstem.

H8-LB5
This structure is located at station 9+75. This site is a sharp left veering meander bend with a sandy bar and several pieces of LWD on left bank. There is an 8 foot cutbank on the right and some trees that have fallen into the channel at the downstream end of the bend that have recruited considerable small woody debris. This structure consists of one log placed in front of the fallen trees and several anchoring logs tied into the banks and to other LWD. This structure is designed to compliment the accumulation currently present and to promote sediment and woody debris retention.

H9-CJ8
This structure will be placed at station 10+60. The site is just downstream of a gentle bend in the creek with an 8 foot cutbank to the right and 4 foot high flood plain to the left. Currently an accumulation of woody debris splits flow into 3 different paths as it cascades over the obstructions at different heights. The structure proposed for this site will build upon the existing structure enhancing the range of flows where hydraulic complexity is realized. Logs will be placed to support more cascades and flow paths and the structure will be shored with logs anchored into both banks. This structure is designed to promote continued split flow conditions and woody debris and sediment retention.

H10-CTR4
This structure will be placed along a straight section of creek at station 12+03. There are approximately 4-5 foot high floodplains on both sides of the creek with steep banks at this site. This structure marks the approximate transition between the upstream and downstream segments of Reach 2. The structure consists of one log placed parallel to the channel in the center of the thalweg with two logs perpendicular to flow that shore the first by anchoring them into the right bank. Another log is placed diagonally with the upstream end in the center and the downstream end in the bank. This structure is designed to retain sediment and form a bar within the structure and promote erosion of the left bank, thereby encouraging meander bend development.

H11-RB5
This structure will be placed upstream of an existing woody debris accumulation and small vegetated mid channel bar at station 12+80. The current LWD splits flow and has created a deep pool on the left and riffle on the right. The structure is designed to enhance the current accumulation of LWD and deflect flow toward the left bank to promote bank erosion and channel migration to the south east. This structure will support the mid-channel bar promoting the creation of a forested island over time.

H12- CTL 4 & H13- CTL 4
These structures will both be located along the straight section of creek upstream of structure H11-5. They are located at station 14+27 and 15+43 respectively. The structures consists of one log placed parallel to the channel in the center of the thalweg with two logs perpendicular to flow that shore the first by anchoring them into the left bank. Another log is placed diagonally with the upstream end in the center and the downstream end in the bank. These structures are designed to retain sediment and form a bar within the structure and promote erosion of the right bank encouraging meander bend development.

H14-LB5
This structure will be located on a left veering bend at station 16+83. There is an 8 foot high cutbank on the right and a 4 foot high floodplain on the left. One log will be placed along the base of the cutbank at the lower end of the bend and will be anchored to existing wood buried in the floodplain. The lower end of this channel spanning log will be secured with a combination of logs. One log will be placed downstream of the spanning log parallel to the left bank in the thalweg. A third log will be placed downstream, perpendicular to the channel and anchored into the right bank to provide stability to the structure. Another log will be placed along the left bank anchoring the structure into the left bank. This structure is designed to encourage flow toward the left bank to promote sinuosity and recruit sediment from the bank. This would provide much needed sediment to the creek in Reach 2 and promote channel migration.

H15- CTR4
This structure will be placed station 17+75 just downstream of the gravel retention pond outlet. Six foot high cut banks occur on both sides of the creek at this site. The structure consists of one log placed parallel to the channel in the center of the thalweg with two logs perpendicular to flow that shore the first by anchoring them into the right bank. Another log is placed diagonally with the upstream end in the center and the downstream end in the bank. This structure is designed to retain sediment and form a bar within the structure and promote erosion of the left bank thereby encouraging meander bend development.

CONSTRUCTION SEQUENCE

As described above, the overall strategy of this project is to recruit sediment and woody debris from the banks in the upper segment of the reach in order to capture and store them in the lower sections of the reach. With this in mind, the logical strategy is to have the structures in the lower segment in place prior to the structures in the upper segment. Hence, implementation of this project should proceed from downstream to upstream.

For purposes of construction logistics, Reach 2 is divided into three segments, Lower, Middle and Upper, that can be prioritized if construction activities are completed in phases. This delineation is also useful in terms of project planning and permitting because each segment will require a specific access route and staging area. Within each of those segments, the individual structures are prioritized according to functionality and success in meeting project objectives.

The Lower section extends from station 0+00 to station 7+00, just upstream of structure H7-LJ27. The structures in this segment should be constructed prior to those in the other 2 segments. This lower portion of the reach can be accessed from the east side of the creek from an existing dirt road. If all structures in this segment are constructed during one phase of work, construction can occur in any respective order. If a subset of structures is constructed in a given phase, the priority of implementation should reflect the following bulleted list.

- *H1-A15*
- *H7-LJ27*
- *H5-CR8*
- *H4-RB4*
- *H6-LJ27*
- *H2-RT3*
- *H3-LT3*

The Middle segment which extends from station 7+00 to 13+50 should be prioritized next. Access to the Middle segment is more complicated, it will likely need to be accessed from the west side of the creek from the Northern State Hospital property. The priority for structure placement in this segment is as follows:

- *H9-CJ8*
- *H8-LB5*
- *H11-RB5*
- *H10-RT4*

The Upper segment extends from station 13+50 to 18+62 and should be prioritized last. This segment can be access from either side of the creek. The structures in this section should be built from downstream to upstream although the order of construction is not as critical as in the other segments. The priority for structure placement is as follows:

- *H12-RT4*
- *H13-RT4*
- *H14-LB5*
- *H15-LT4*

LARGE WOODY DEBRIS CONSTRUCTION

The proposed construction includes the installation of 15 LWD structures. Two of these are engineered log jams constructed primarily with woody debris and are designed to emulate naturally occurring accumulations of large woody material on rivers and streams in the Pacific Northwest. Natural and constructed logjams provide a well-established role in physical and ecological riverine processes, including the creation of scour pools, the sorting of sediment in tail-out riffles and the development of multiple flow paths. In addition increased structural complexity provides ideal cover for juveniles during feeding and resting periods.

The following is a typical construction sequence for Engineered Log Jams.

1 - Excavate Footprint

The initial step is to excavate the log jam's footprint to the specified elevation. All excavated material shall be stockpiled nearby and incorporated in the log jam as backfill. This can be done efficiently using a dozer, however the footprint elevation is typically below the groundwater table and dewatering of the footprint area will be necessary. Water removed from the excavated area is turbid due to sediment disruption during excavation and must be treated prior to being reintroduced into the river. This water should be routed through a stilling basin to allow for settling of sediments. Much of this water will infiltrate into the ground prior to reconnecting with the river, but some overland flow is probable. This overland flow should be routed through filtration berms to reduce turbidity prior to reintroduction to the river. Depending upon site conditions, a series of settling basins may be necessary.

2 - Excavate for Footer and Key Rootwads

Additional excavation will be required to provide space for footer placement and to accommodate for the key member rootwads. This depth is dependent upon the actual dimensions of the footer and key logs being placed, but should be sufficient to account for future racked log placement. All excavated material shall be stockpiled nearby and incorporated in the log jam as backfill.

3 - Place Footer log(s)

Footer logs are placed such that their bole elevation is equal to the footprint elevation. Extensive local excavation for the footer rootwad(s) may be required.

4 - Place Key Members

Key members are placed parallel to the dominant flow direction, in direct contact with the graded footprint, and must be flush with the footer(s). Once all key members are placed, it may be necessary to adjust the footer(s) to enhance the continuity of the structure.

5 - Placement of 1st Stacked Layer and Initial Backfill

The first layer of stacked members is placed perpendicular to and on top of the key layer. The exact quantity and placement is dependent upon the type of log jam being constructed and its intended objectives.

6 - Initial Backfill Placement

At this stage, it is suggested that initial backfill activities commence. This helps facilitate QA/QC of the structure's foundation. It is imperative that backfill materials do NOT cover the first stacked layer at this time.

7 - Place 2nd Stacked Layer

The second stacked layer is placed upon the first, parallel to the key members. Placement should maximize interlocking with key members. The number of logs within the second layer is dependent upon the site specific structure application.

8 - Place 3rd Stacked Layer

This layer is placed parallel to the 1st stacked layer and should be placed such that interlocking with the 1st stacked layer is maximized.

9 - Additional Backfill Placement

Further backfill activity is recommended at this stage, though not mandatory.

10 - Place 4th Stacked Layer

The fourth stacked layer (if recommended) is also placed parallel to the key members. As before these logs are placed such that interlocking with the 2nd and 4th layers is maximized.

11 - Final Backfill Placement

The final backfill materials should cover the entire structure. The thickness of backfill materials above the composite structure's elevation is determined through structural stability analysis.

12 - Placement of racked logs

Racked logs are placed upstream of the composite structure and in many ways mimic the woody drift that accumulates on natural log jams. The structural complexity of these racked logs can alter flow dynamics local to the installations and can play a significant role in the immediate and long-term effects of logjam placement.

The additional 13 LWD structures are more chaotic in design and emulate features found in migrating streams with mature riparian stands. The typical construction sequence for these LWD structures is as follows:

1 - Excavate for Lowest Members

The initial step is to excavate a depression large enough to accommodate burial of the rootwad of the key member(s) and if applicable the lowest anchor log(s). Excavation should be to a depth at which the boles of the logs will lay directly on the stream bed. A trench(es) will be excavated to the specified dimensions. Water may fill the depression but dewatering will not be necessary. All excavated material shall be stockpiled nearby and incorporated in the structure as backfill.

2 - Place Lowest Members

The key member(s) is placed parallel to the dominant flow direction in direct contact with the stream bed with rootwad facing upstream. One inch biodegradable rope should be placed under key member at the head and foot for tying structure together after other members are placed. The anchor log should be placed in conjunction with or in some cases prior to the key member. The anchor log should be horizontal with the bole resting directly on the streambed or the key member. Trenching can be done efficiently using an excavator.

3 - Backfill

Trenches dug for the initial log placements should be backfilled at this point in the construction. It may be more efficient to backfill after every individual log is placed through the entire construction of the structure, this can be decided by the Engineer. In most cases, excavated material can be sidecast locally and incorporated back into its original location.

4 - Excavate Trenches for Additional Anchor Log(s)

Excavate trenches to the specified dimension into the bank perpendicular to the key member at the head and foot of the key member. Excavated material shall be stockpiled nearby and used to backfill the trench or incorporated in the log jam.

5 - Place Additional Anchor Log(s)

Place anchor logs perpendicular to key member with rootwads in the path of the stream. Logs should be placed in a position with the bole of the anchor log resting directly on the key member and the anchor log is horizontal. One inch biodegradable rope should be placed under anchor logs in necessary places for tying structure together. Backfill the trenches with stockpiled material.

6 - Tie Members Together

Tie members together at all contacts with 1-inch biodegradable rope. Smaller jams without racked logs on the upstream side experience greater hydraulic forces acting on them and are more susceptible to movement. The rope shall provide added stability to the structures to keep them in place before natural sedimentation processes begin to stabilize the structure.

We appreciate the opportunity to be of service to Skagit County Public Works. Please call if you require more information or have questions regarding this report.

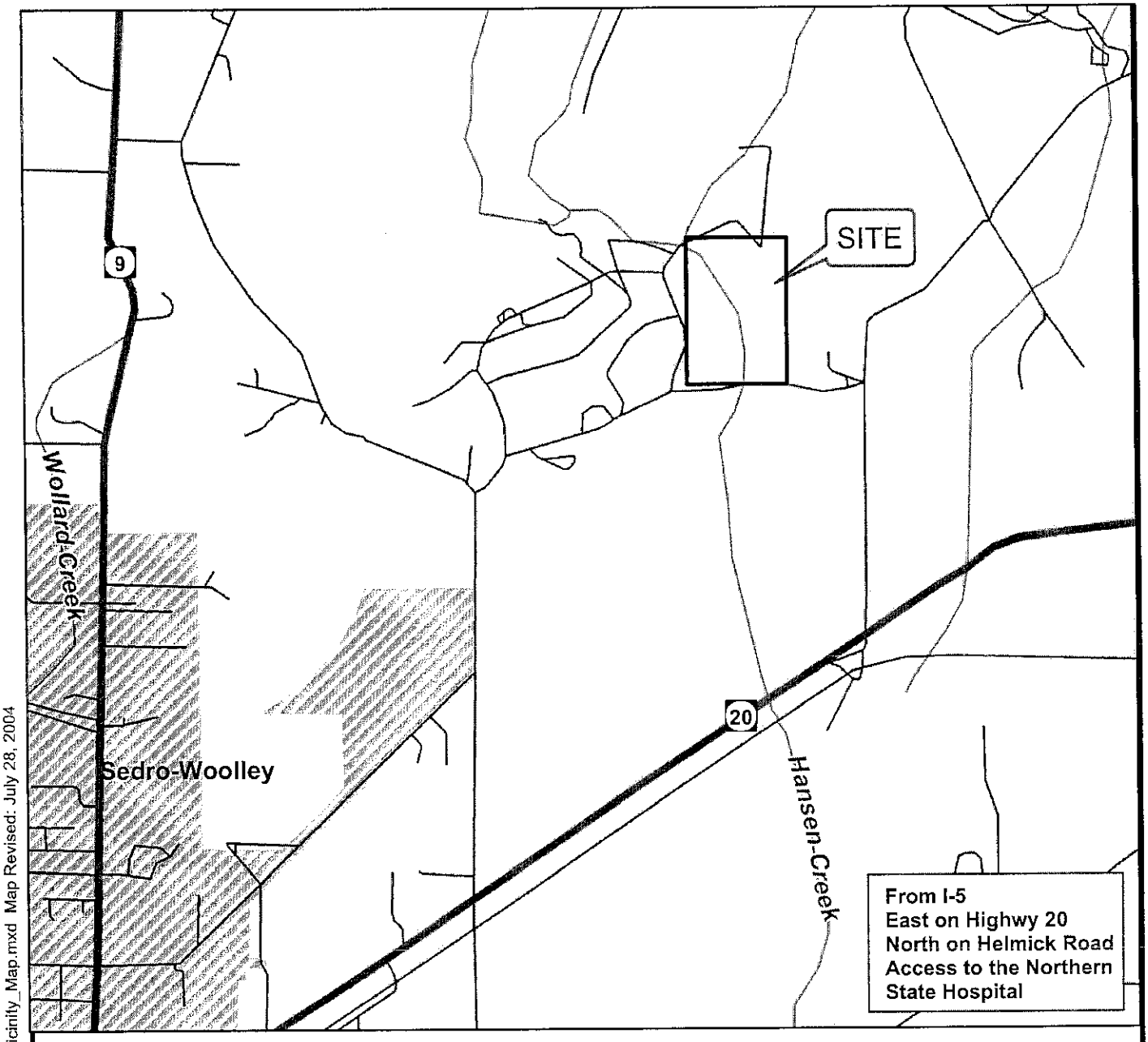
Respectfully submitted,

GeoEngineers, Inc.

Tracy Drury, PE
Associate, River Science and Engineering

TD2:ims
BELL: \\BAM\Projects\0\0220072\00\Finals\022007200report.doc

Three copies submitted



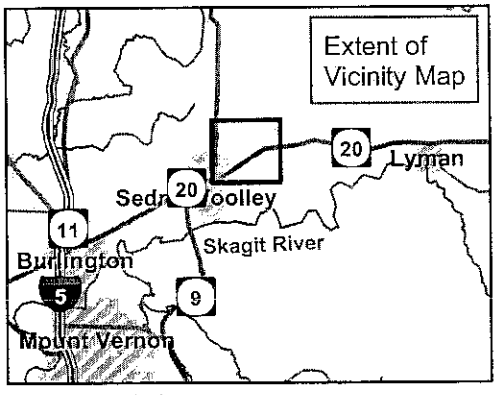
Data Sources: Interstates, state routes, and roads from TIGER 2000.
County boundaries, cities, and waterbodies from Department of Ecology.
Topographic map from Terraserver; USGS.

All locations are approximate.

Lambert Conformal Conic
Washington State Plane North
North American Datum 1983

N

0 750 1,500 Feet



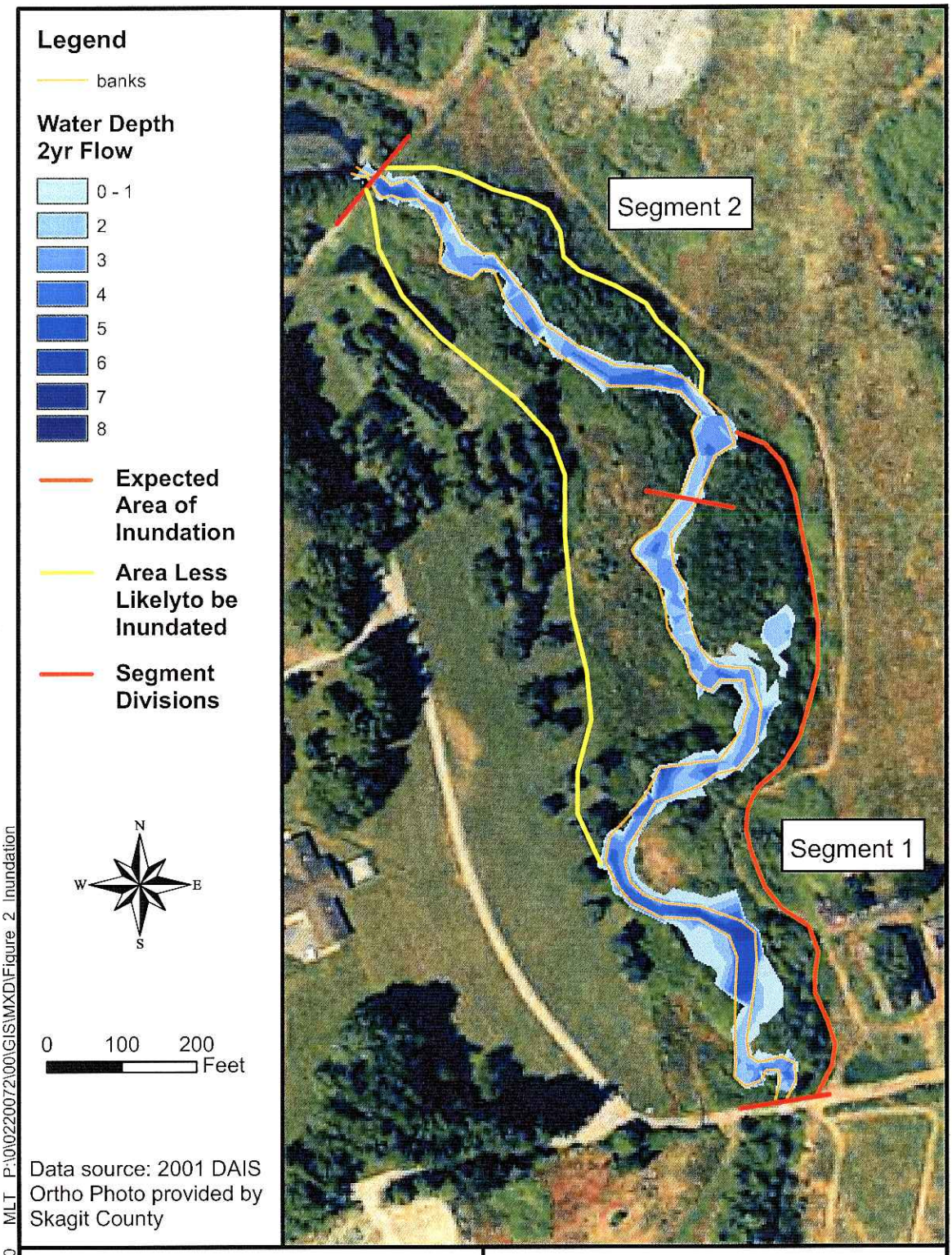
Note: This drawing is for informational purposes. It is intended to assist in showing features discussed in an attached document.

GeoEngineers

HANSEN CREEK HABITAT RESTORATION

FIGURE 1: VICINITY MAP

Office: BAM MLT Path: \P\02200721001\GIS\MXD\Hansen_Vicinity_Map.mxd Map Revised: July 28, 2004

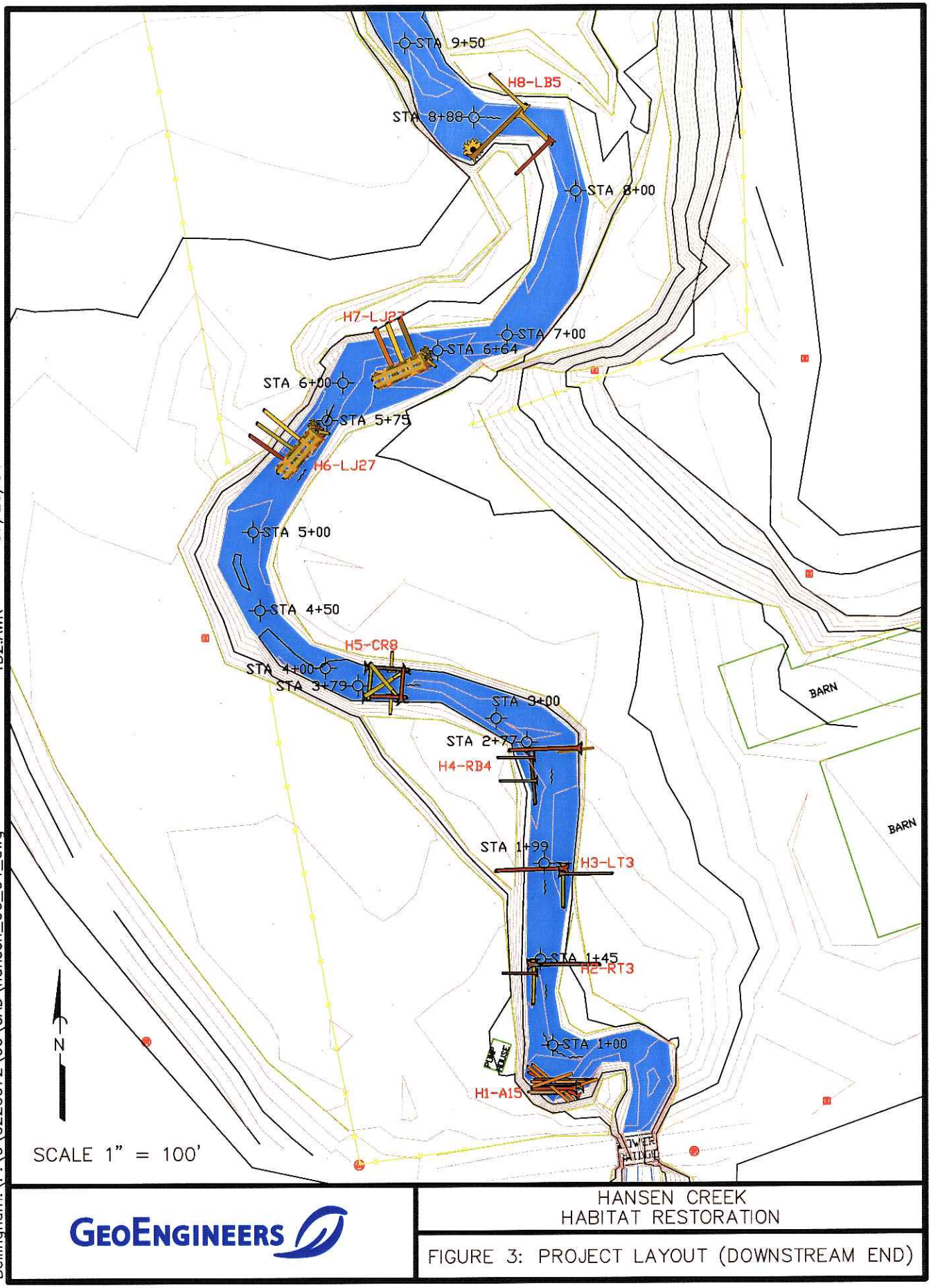


Project: 0220-072-00 MLT P:\0\02200721\00\GIS\MXD\Figure 2 Inundation

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 2 - FLOOD INUNDATION

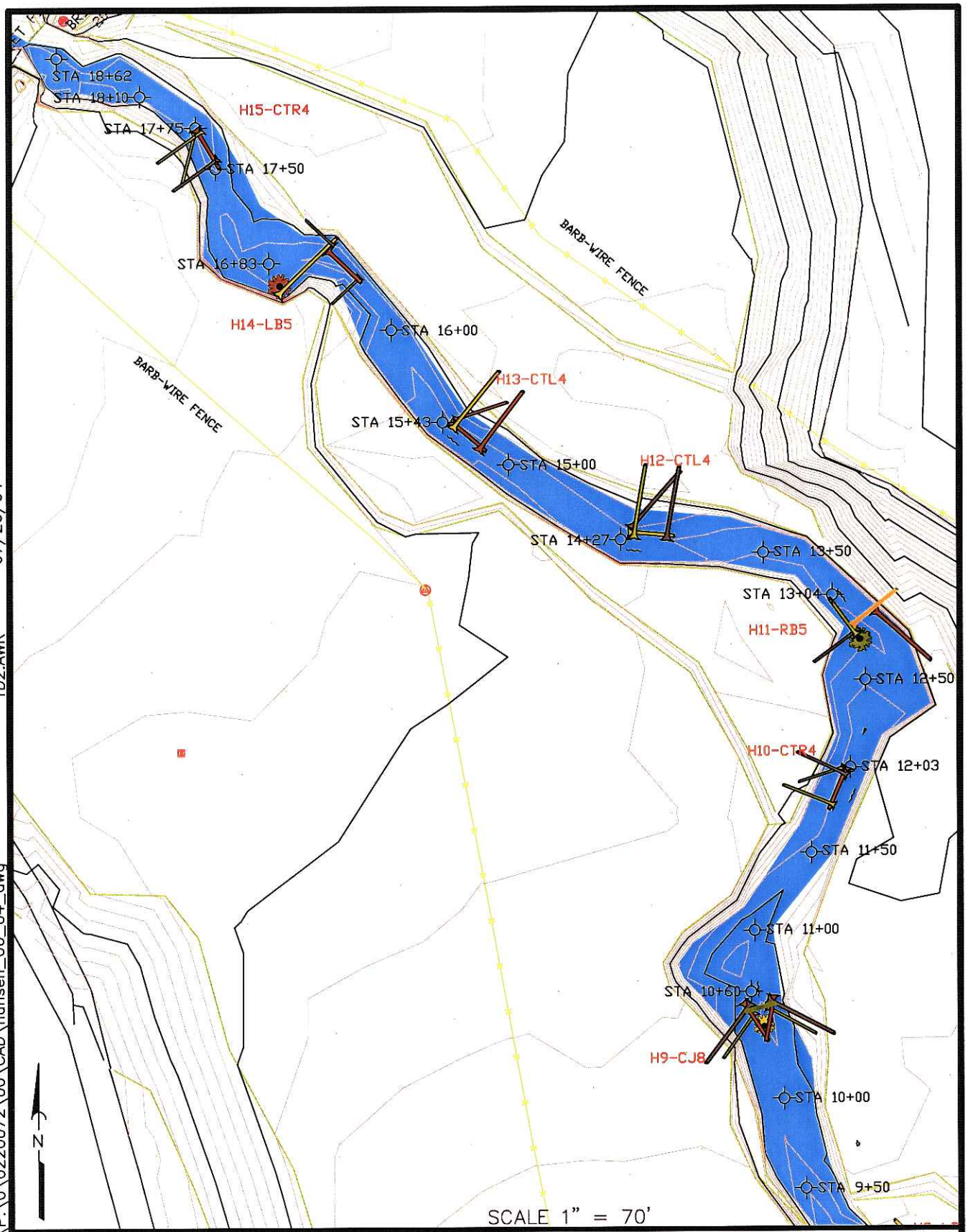


Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_dwg TD2:AWR 07/26/04

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 3: PROJECT LAYOUT (DOWNSTREAM END)

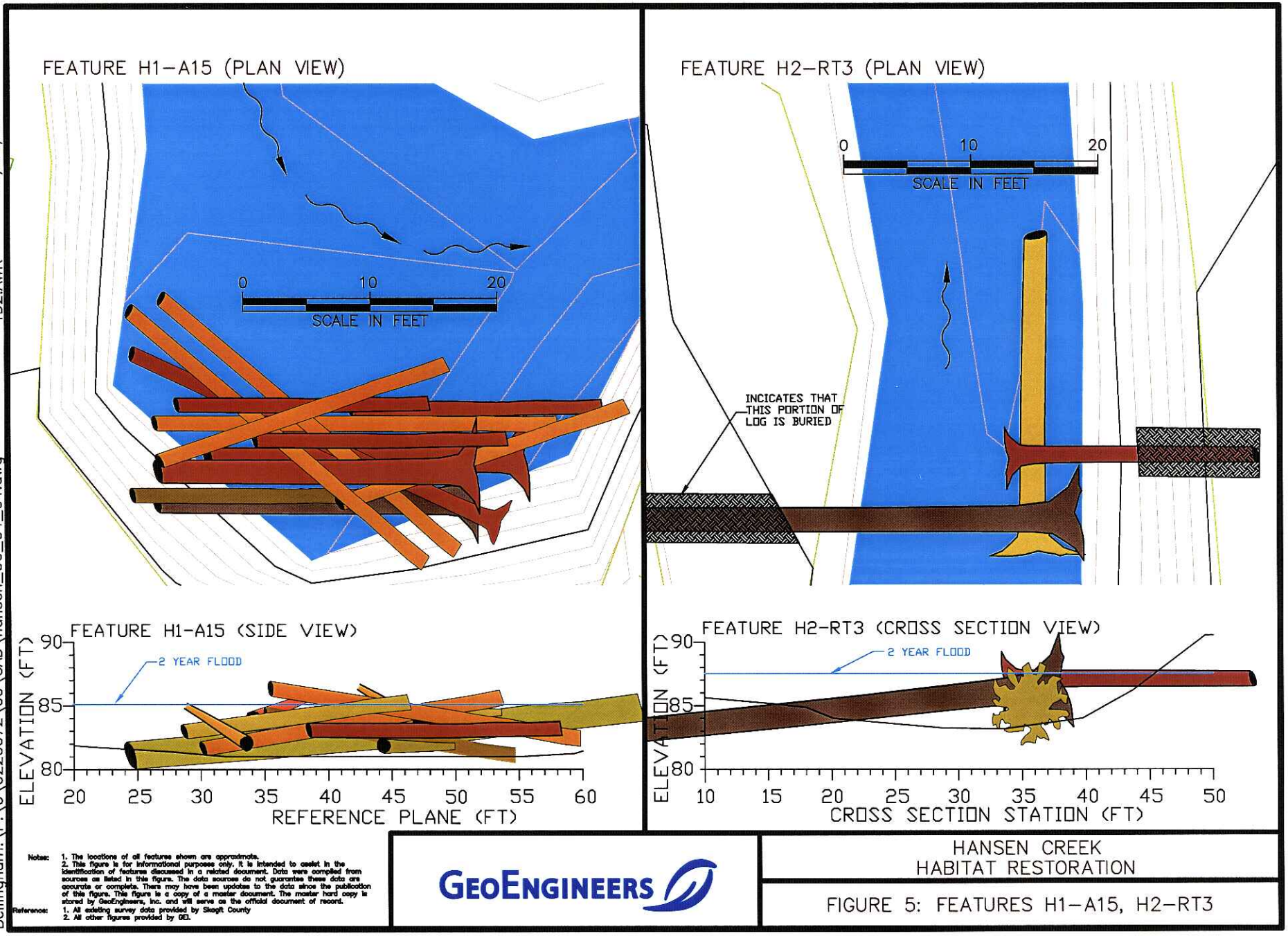


Bellingham: P:\0\0220072\00\CAD\hansen_06_04_dwg TD2:AWR 07/26/04

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 4: PROJECT LAYOUT (UPSTREAM END)



Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

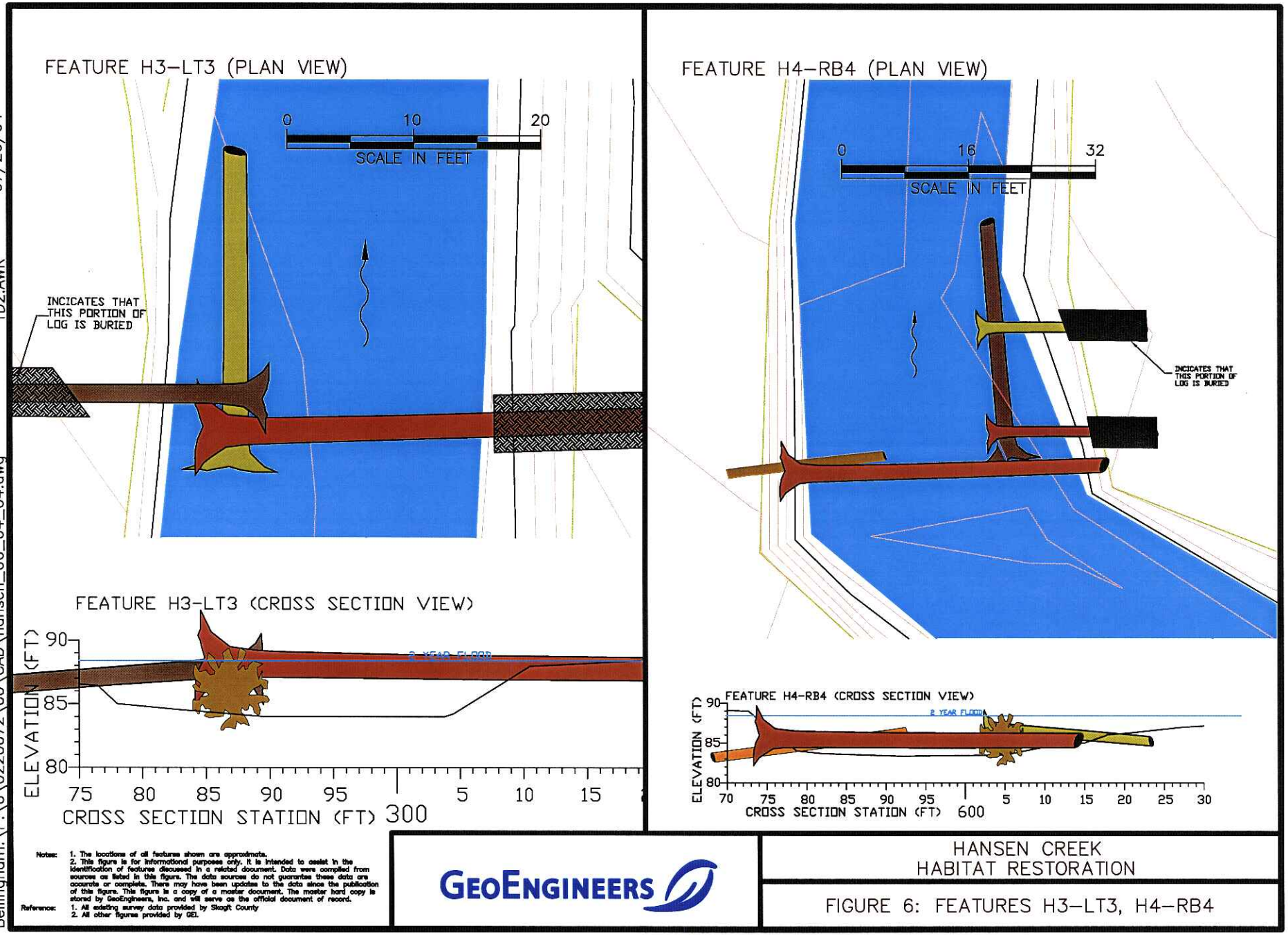
Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 5: FEATURES H1–A15, H2–RT3

Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_04.dwg TD2:AWR 07/26/04



Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_04.dwg TD2:AWR 07/26/04

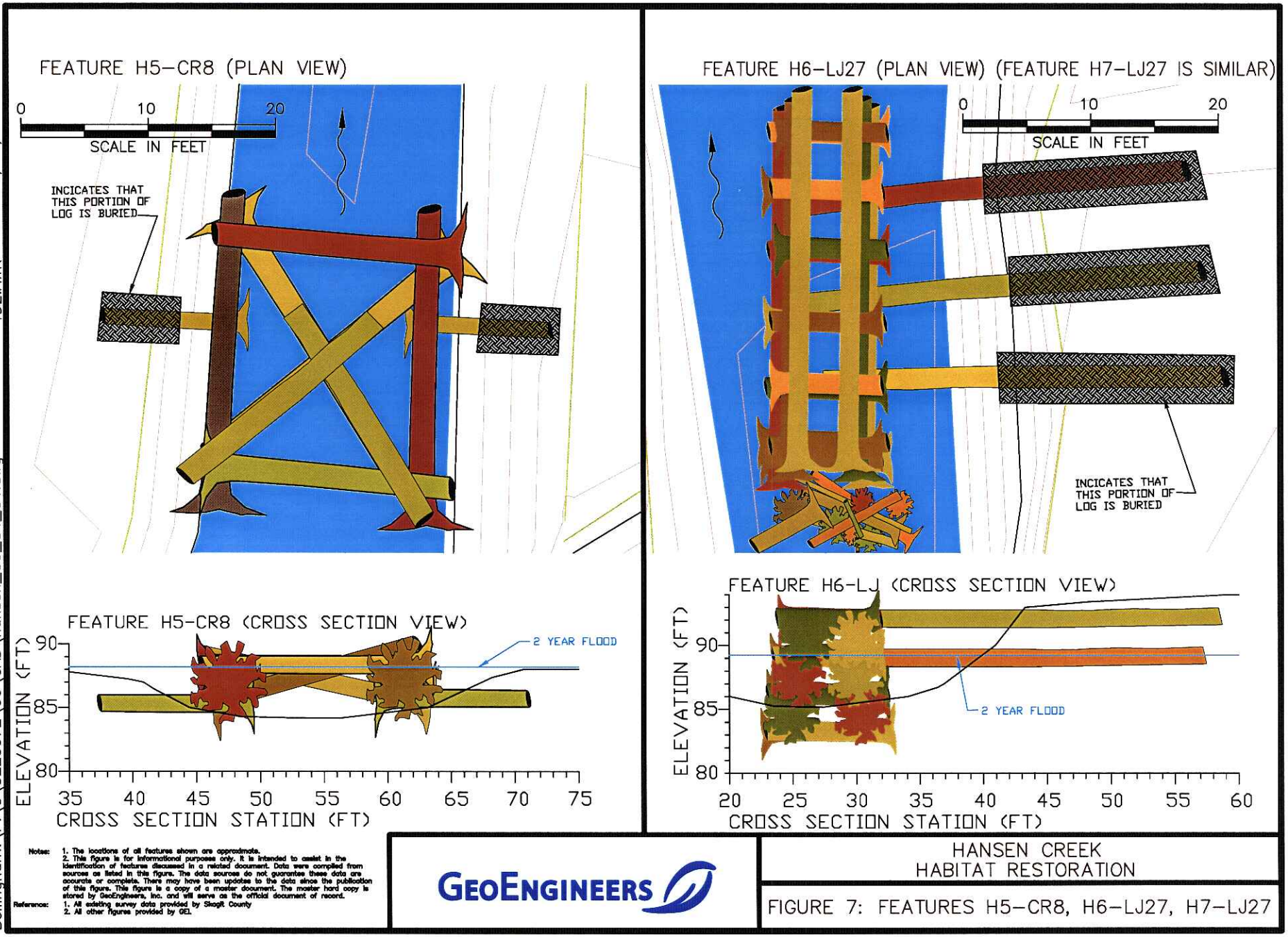
Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 6: FEATURES H3-LT3, H4-RB4



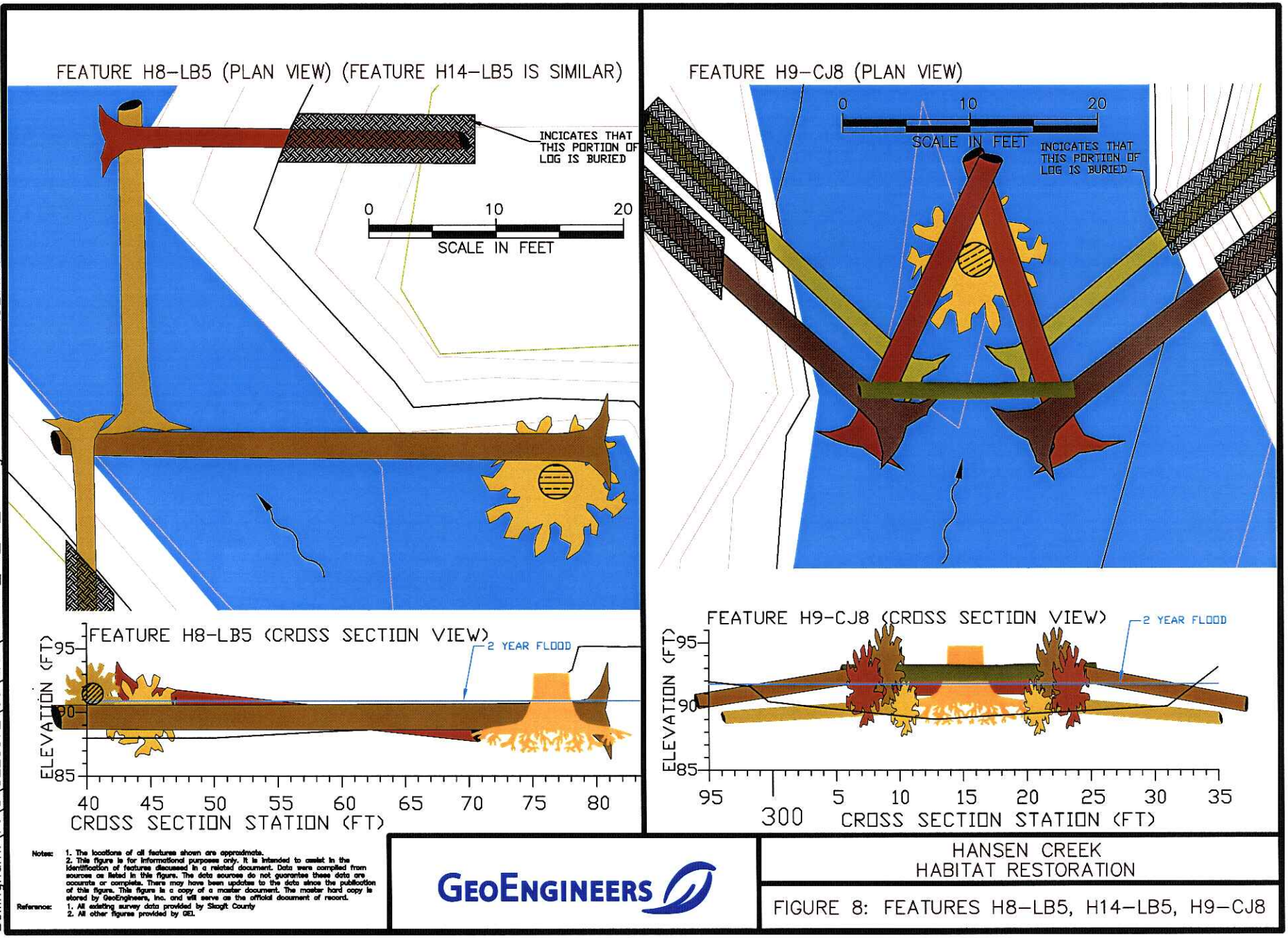
Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 7: FEATURES H5-CR8, H6-LJ27, H7-LJ27



07/26/04 TD2:AWR Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_04.dwg

Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

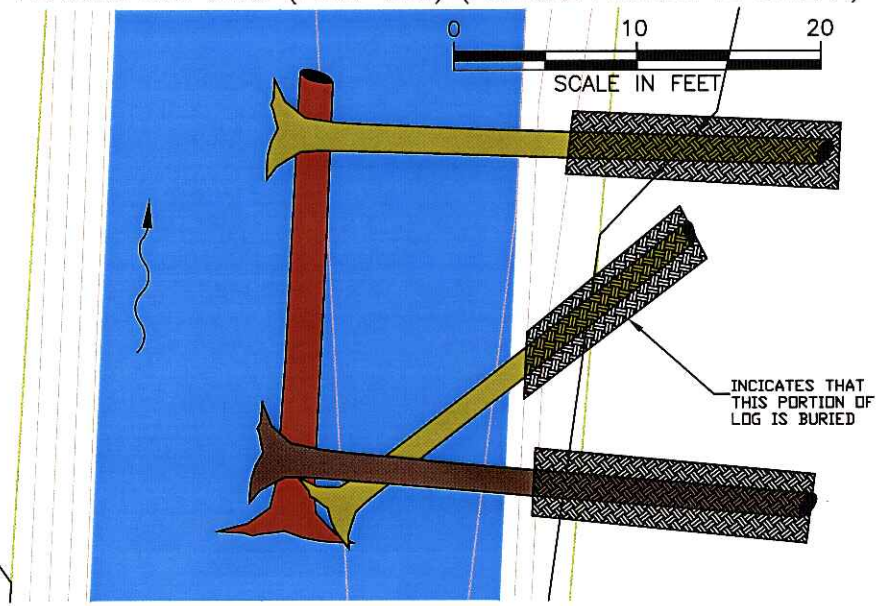
GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

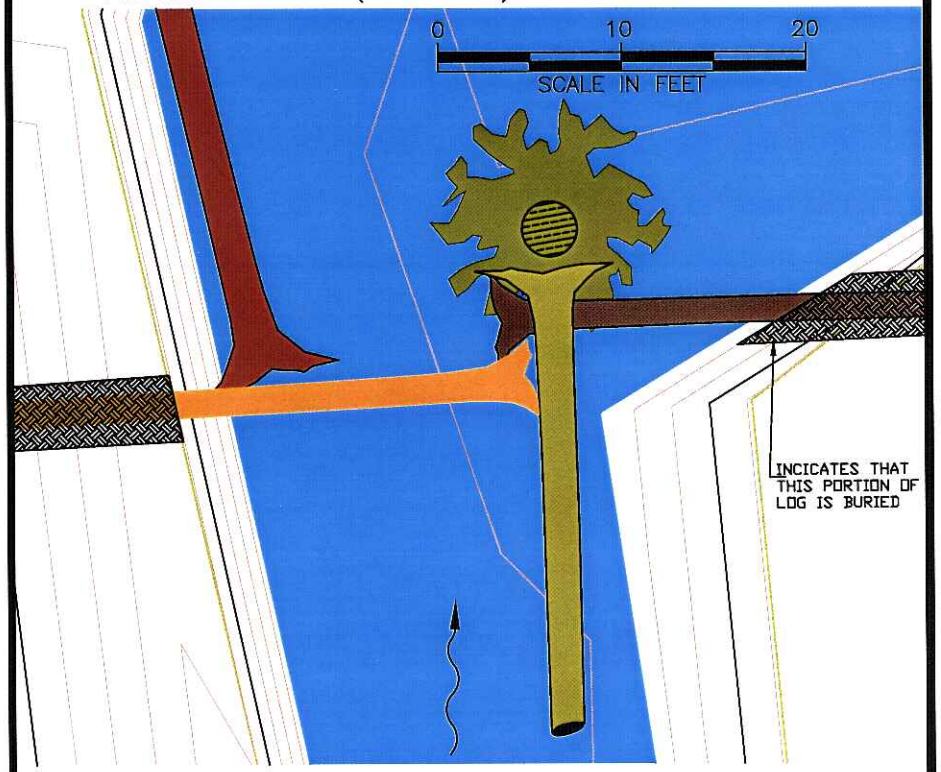
FIGURE 8: FEATURES H8-LB5, H14-LB5, H9-CJ8

Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_04.dwg TD2:AWR 07/26/04

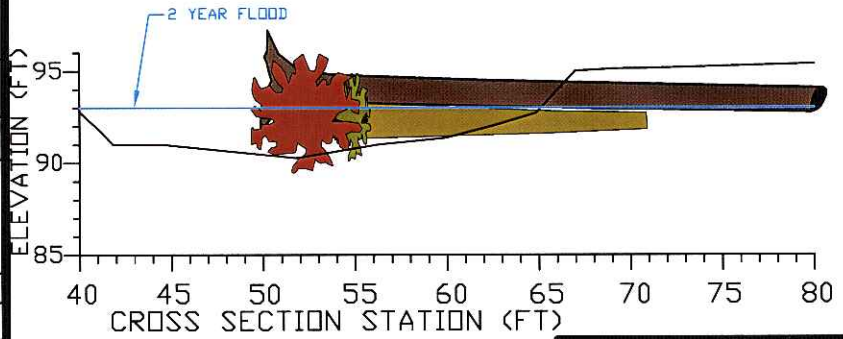
FEATURE H10-CTR3 (PLAN VIEW) (FEATURE H15CTR4 IS SIMILAR)



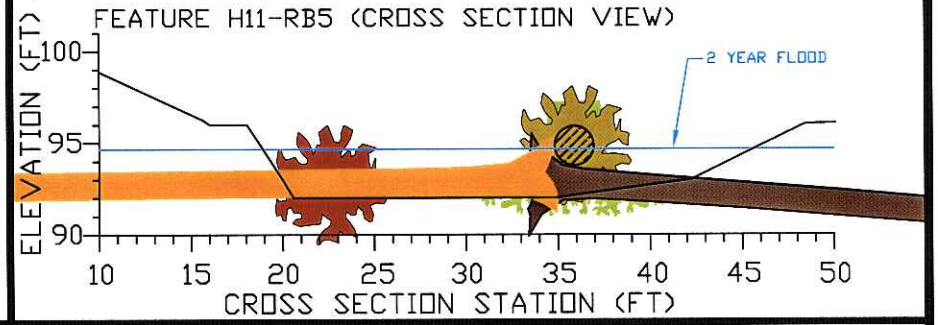
FEATURE H11-RB5 (PLAN VIEW)



FEATURE H10-RT3 (CROSS SECTION VIEW)



FEATURE H11-RB5 (CROSS SECTION VIEW)



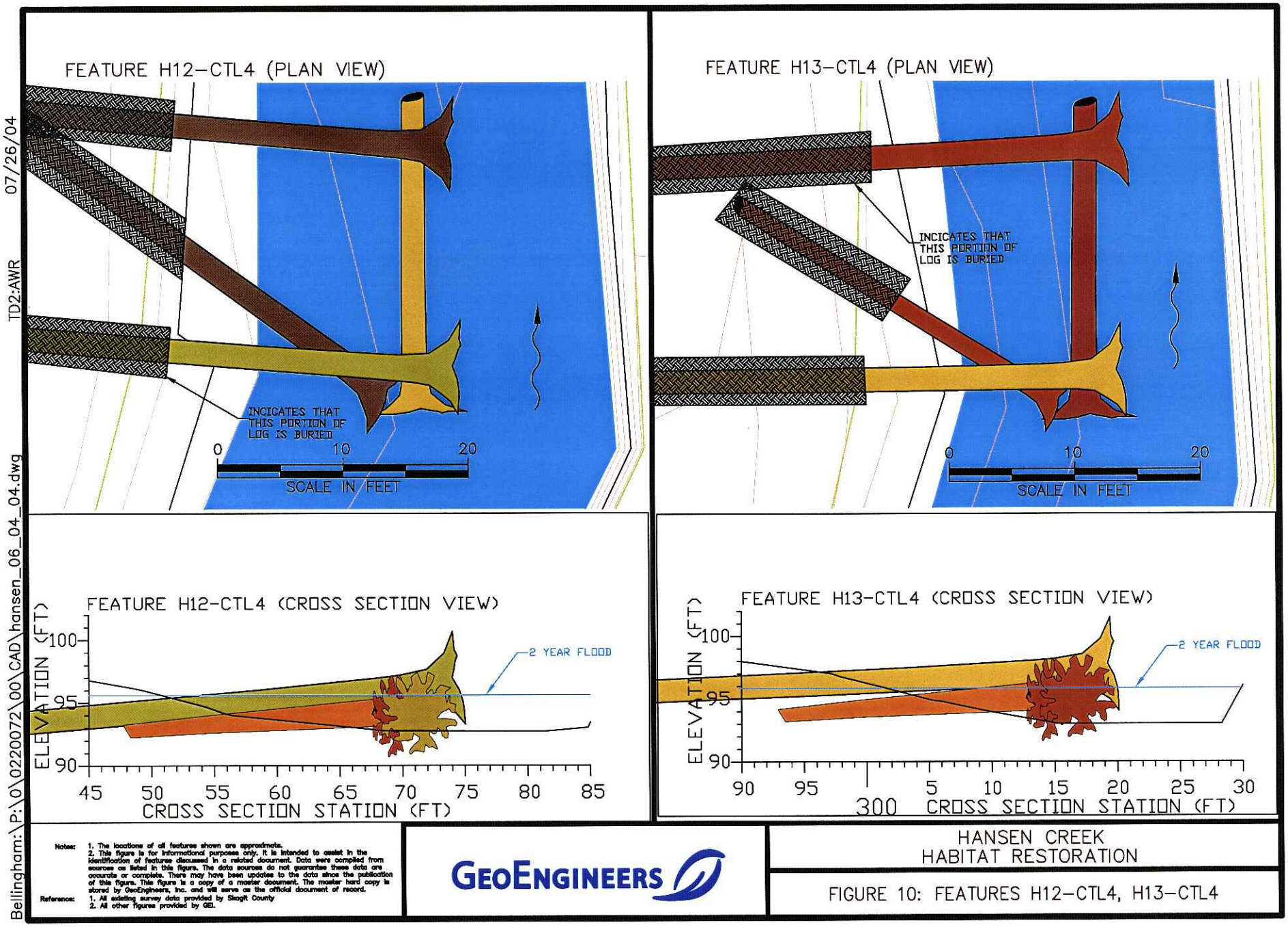
Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 9: FEATURES H10-CTR4, H15-CTR4, H11-RB5



Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_04.dwg TD2:AWR 07/26/04

Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 10: FEATURES H12-CTL4, H13-CTL4

Quantity Takeoff and Cost Estimate -- Hansen Creek 7/22/2004

Materials

Log Spec	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6	Spec 7	Spec 8	Spec 9
Length (ft)	10	20	25	30	25	30	45	5	20
Diameter (in)	15	15	15	18	24	24	24	36	15
Rootwad dia.(in)	45	45	45	48	72	72	72	144	n/a

# of Logs By Structure Breakdown

Structure	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6	Spec 7	Spec 8	Spec 9	Total
H1-A15		3				2		2	8	15
H2-RT3		1			1		1			3
H3-LT3				1	1		1			3
H4-RB4		2				1	1			4
H5-CR8	2				4	2				8
H6-LJ27	18			3		6				27
H7-LJ27	18			3		6				27
H8-LB5				2	1		1	1		5
H9-CJ8				2	2		2	1	1	8
H10-CTR4			1	2	1					4
H11-RB5				2	1		1	1		5
H12-CTL4					1		3			4
H13-CTL4				1	1		2			4
H14-LB5		1	1		1		1	1		5
H15-CTR4				3	1					4
Total	38	7	2	19	15	17	13	6	9	126

Notes:
1. The locations of all features shown are approximate.
2. This figure is for informational purposes only. It is intended to assist in the identification of features discussed in a related document. Data were compiled from sources as listed in this figure. The data sources do not guarantee these data are accurate or complete. There may have been updates to the data since the publication of this figure. This figure is a copy of a master document. The master hard copy is stored by GeoEngineers, Inc. and will serve as the official document of record.

Reference:
1. All existing survey data provided by Skagit County
2. All other figures provided by GEI.

GeoEngineers

HANSEN CREEK
HABITAT RESTORATION

FIGURE 11: QUANTITY TAKE OFF

Bellingham:\P:\0\0220072\00\CAD\hansen_06_04_04.dwg TD2:AWR 07/26/04