Allen Lake Outlet Rapid Assessment

February 7, 2011

King County

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Allen Lake Outlet Rapid Assessment

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February 7, 2011

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1 Introduction

The Water and Land Resources Division, Stormwater Services Section (SWS), Capital Improvement Projects Feasibility Program, initiated a reconnaissance team to assess the condition of an unnamed low gradient channel, WRIA 08.0111A, that drains Allen Lake (formerly known as Mud Lake) near Sammamish, Washington (Figure 1). The team conducted a site visit September 7, 2010 and observed points on a reach of channel that extends approximately 6000 feet from Northeast 8th Street to 244th Avenue Northeast (Figure 4, Figure 5, and Figure 6). Follow up visits were conducted September 16, October 26, and December 14, 2010. The purpose of the site visits was to collect information in order to prepare a brief site assessment, the intent of which is to assess the need for a capital improvement project.

Rick Lowthian, SWS Senior Engineer, reviewed a complaint regarding Tributary 0111A, the Allen Lake outlet channel, under Drainage Investigation Report number 2010-0386. The complaint had been referred to him by the City of Sammamish May 21, 2010. In May 2010, Allen Lake rose and inundated a portion of the private property on its shore causing nuisance damage. Mr. Lowthian referred the complaint to the Capital Services Unit, which initiates feasibility studies to evaluate capital improvement opportunities.

This rapid assessment report describes and assesses the capacity of Tributary 0111A to convey expected flows. Although it presents possible alternatives, it is not intended to evaluate feasibility of capital improvements or determine preferred alternatives to forward to funding in the capital improvement six-year plan. Nothing in this report should be interpreted as a commitment by King County to take any action.

2 Project Goals and Objectives:

The purposes of this rapid assessment report are to:

- Provide site background
- Provide a description and assessment of the site conditions
- Provide a hydrology and hydraulic summary
- Provide a professional technical judgment regarding potential projects that could alleviate flooding at the site.

3 Site Conditions

The stream reach begins at Allen Lake in the northwest quarter of Section 35, Township 25 North, Range 6 East, Willamette Meridian, King County, Washington. From Allen Lake, the reach passes through road and driveway culverts through the west half of Section 26, Township 25 North, Range 6 East, Willamette Meridian, King County, Washington. The channel cross-section varies between a neat trapezoidal cross-section and irregular banks with a shallow bed. In most places, the channel has dense reed canary grass or aquatic

vegetation. In many places, the reach has banks densely vegetated with shrubs or woods. Beavers have obstructed culverts on the channel, and bank sloughing has been reported to obstruct the Northeast 8th Street culvert.

4 Historic Background and Data Records

A channel that would have drained Allen Lake easterly to Patterson Creek was surveyed by the General Land Office (GLO) in 1874 (mapped in Figure 2). The GLO survey notes do not identify a channel that would drain Allen Lake to the north.

The existing channel (Tributary 0111A) that drains Allen Lake to the north was excavated by the father of Jeff Dodd, according to Jeff Dodd's friend, Joe Bookter (1502 250th Avenue Northeast). Mr. Dodd's father encountered hardpan during excavation, so some of the channel remained shallow. The Dodds homesteaded this area in 1911.

John Gronlund excavated the channel near 250th Avenue Northeast and downstream with a bulldozer in the early 1970s, according to Gail Michelman, a long-term resident of the neighborhood and daughter to Mr. Gronlund. This reach was previously no more than a swale.

The reach of channel from Northeast 8th Street to 244th Avenue Northeast, downstream, crosses seven properties that have notice on title for streams. Three of the notices from 1993 to 1999 are for perennial streams and four of the notices from 2002 to 2004 are for perennial streams bearing salmonids. Allen Lake and some of the surrounding land is classified as a 1(c) wetland, which is approximately fifteen acres. Eight hundred feet to the west is a class 1(d) wetland, which is approximately sixty-three acres.

Beavers have historically occupied this area. Removal of beaver dams may reduce peak flow attenuation in the Allen Lake outlet channel.

Review of records indicates that on December 2, 1968, G. Robert Schroeder, a former King County Inspector, identified a partially obstructed 24 inch culvert at parcel 2625069054 (area "C", as quoted below) as "the area restricting drainage". He had responded to a complaint from Chris Klineburger regarding flooding on 244th Avenue Northeast at the southwest end of the lake (upstream from Northeast 8th Street). Mr. Klineburger owned property south of Allen Lake at the time he complained to King County, Dec. 2, 1968. Mr. Schroeder wrote that "removal of the obstruction created in area 'C' can lower the w.s. elev. of Mud Lake appreciably." The culvert was identified as a problem again and replaced by King County in 1995. The City of Sammamish replaced the unimproved part of 244th Avenue Northeast that was subject to this flooding with a bridge in 2010.

In early November 2006, at least eight residents of 250th Avenue Northeast, 258th Avenue Northeast, and Northeast 8th Street submitted drainage complaints online regarding flooding. These complaints followed upon three similar complaints logged in January and February, 2006 and included water in the basement of the house at parcel 2625069052 and in the crawlspace of the houses at parcels 2625069091 and 2625069010. The online complaints

were consolidated and investigated under Drainage Investigation Report number 2006-0075. Technical assistance provided from the investigation recommended first improving driveway culverts on private property to improve capacity of the drainage system.

Complaints regarding flooding along 250th Avenue Northeast were also logged in 1987, 1991, 1993, 1994, and 1997. Drainage complaints regarding beaver dams and obstructions at Northeast 8th Street and along 250th Avenue Northeast were logged by property owners adjacent to Allen Lake in 1985, 1996, 1997, 2002, and 2010.

Complaints regarding impacts of upstream development were submitted for parcel 3525069005, which is east of Allen Lake, in 2003 regarding the Beaverdam Division I & II plats and in 2005 regarding the 2006 Seattle Street of Dreams.

5 Field Findings

5.1 Note on Stationing

An overview of the observed stream reach and diagram of approximate stationing is in Figure 3 on page 14.

"Stationing" is a convention that refers to measurements of distance. In this report it represents a distance downstream from the centerline of Northeast 8th Street as measured in the Meredith Incorporated survey of the channel for RW Beck (1995). A "plus" sign (+) is used in measurement of downstream distance. The "plus" sign separates the hundreds digit from the tens digit, i.e. "station 12+50" is 1,250 feet downstream from the centerline of Northeast 8th Street. Vertical measurements of elevation and depth do not include a plus sign.

5.2 Observations

A description of each of the points visited along the reach follows, with reference to the lettered tags in Figure 4, Figure 5, and Figure 6 (pages 15, 16, and 17).

A. Northeast 8th Street (Photograph 1 & Photograph 2).

Two culverts are located at this crossing, a 30-inch corrugated polyethylene pipe (CPEP) and an 18" CPEP. Both were installed in 1995 under King County Roads Maintenance drainage tracker number M46224 (Appendix B, page 20). The 30-inch pipe has a bar rack on its inlet and appears to be obstructed by sloughed bank material and/or decayed plant material. The 18-inch pipe is connected to a Type 2 catch basin at its upstream end; a bird cage type bar rack is the only inlet to the catch basin. The intent of the 18-inch pipe was to reduce the likelihood that Northeast 8th Street would be overtopped if the 30-inch pipe were blocked by beavers (Jim Eagan, designer).

These culverts were cleaned in 2003 under best management practices outlined in Roads Maintenance drainage tracker number 6-0254 (Appendix C, page 23).

High water initially overtops Northeast 8th Street approximately 200 feet west of the culverts (Photograph 3). Water on the road is an annual event (Michael Lucarelli, resident of 905 250th Avenue Northeast). Northeast 8th Street is the sole access for approximately 78 residences.

Blockage on the rim of the birdcage observed September 23, 2010 appeared to be the work of beavers (Photograph 4).

Rainfall the second week of December 2010 inundated Northeast 8th Street (Photograph 16). The depth of water on the crown of the road was measured at 0.9 feet; the water was reported to be as deep as 17 inches at Northeast 8th Street.

B. Channel and culvert at parcel 2625069054 (1021 250th Ave Northeast)

On September 2, 2010, a high point in the channel near the south property line was observed to cause a backwater in the channel toward Northeast 8th Street. The channel slope to and from the high point was gradual, and the depth of flow was shallow at this point. The channel bottom and the banks were vegetated with grass, herbaceous plants, and shrubs (Photograph 5 and Photograph 6).

The upstream neighbor (Michael Lucarelli) confirmed that the water surface was continuous without a noticeable drop across his property. While this backwater was caused at a single point, the channel is shallow through approximately 700 feet upstream, with its bed approximately 15 inches higher than the invert of the 30 inch culvert at 8th Street (Figure 7 and Figure 8).

A 24-inch corrugated metal pipe (CMP) culvert was replaced with a 36-inch CPEP on parcel 2625069054 and the channel was dredged in the vicinity of the culvert under King County Roads Maintenance drainage tracker number 2-837 in 1995. This was a recommendation from RW Beck, July 19, 1995, along with replacement of the Northeast 8th Street culvert. See Appendix D: Frazier Culvert Replacement Plan, page 26.

The top of the access road at this culvert is approximately 1.8 feet higher than the sag on Northeast 8th Street.

During the December 14, 2010 site visit, a more or less continuous water surface backed up from parcel 2625069054 to Allen Lake (Photograph 17). Hydraulic head loss across the 36-inch culvert on parcel 2625069054 (Photograph 18) was determined by hand level to be 0.7 foot.

C. Driveway culvert at parcels 2625069049 and 2625069091 (1117 & 1125 250th Ave Northeast)

A 36-inch corrugated metal pipe with headwall passes under this driveway. The channel upstream and downstream has a deep, trapezoidal cross-section and is densely vegetated with reed canary grass (Photograph 7 and Photograph 8). Aggraded sediment occupies the bottom 0.5 to 1 foot of the culvert.

During the December 14, 2010 site visit, hydraulic head loss across the 36 inch culvert under the driveway was determined by hand level to be 1.8 feet (Photograph 19) soon after the measurement taken upstream on parcel 2625069054. Parcel 2625069049 was partially inundated (Photograph 20) by water backed up behind another driveway culvert at parcel 2625069063. This latter driveway has a 36-inch culvert like parcel 2625069049, but this driveway was overtopped (Photograph 21).

D. Driveway culvert at parcel 2625069010 (1319 250th Ave Northeast)

Culvert at Vitale driveway. A 36-inch corrugated metal pipe lies under this driveway. The channel passes between willows immediately upstream of the culvert (Photograph 9). The channel is rock lined and neatly maintained downstream to the north side of parcel 2625069010 (Photograph 10). Water was pumped from the stream to an off channel pond separated from the stream by weirs. Pumping did not appear to have an adverse impact on flow.

During the December 14, 2010 site visit, water was backed up by the Vitale driveway, as evidenced by a vortex from the water surface to the culvert inlet. Difference in hydraulic head was not measured. The next culvert downstream from here is at Northeast 18th Street. Parcel 2625069010 was partially inundated (Photograph 22).

E. Northeast corner of parcel 2625069066 (1525 250th Ave Northeast), accessed by way of Northeast 16th Street right-of-way.

Flow observed on September 2, 2010 was shallow and the channel bed choked with aquatic vegetation (Photograph 11). The channel downstream entered a dense wooded area (Photograph 12).

Culverts on parcel 2625069066 were removed during summer 2010, according to neighbor Joe Bookter. The culverts had been repeatedly blocked by beavers.

F. Northeast 18th Street.

A 77 by 52 inch pipe arch conveys the stream under Northeast 18th Street (Photograph 13). Upstream of the culvert the channel is densely wooded. Downstream from the culvert the channel is deep, the bed dense with reed canary grass, and the banks densely vegetated with blackberry bushes (Photograph 14).

During the December 14, 2010 site visit, the upstream side of Northeast 18th Street was inundated over the banks in the vicinity of the channel. An attempt to determine hydraulic head loss across the Northeast 18th Street culvert with a hand level yielded no discernable difference in water surface elevation. Inundation of properties upstream from Northeast 18th Street appears to be caused by channel capacity and controls downstream from Northeast 18th Street. The culvert under 247th Place Northeast is the same size as the culvert under Northeast 18th Street, 77 inch by 52 inch pipe arches.

G. Camden Park plat in the City of Sammamish.

The stream does not appear to have a well-defined channel in this broad, deep swale. The floor of the swale is densely vegetated with reed canary grass. A Type 2 catch basin with primary inlet and birdcage drain the swale through a 24-inch culvert under 244th Avenue Northeast (Photograph 15).

During the December 14, 2010 site visit, the water surface upstream from 244th Avenue Northeast was as high as the upper band of the bird cage and the water depth was about 4.2 feet (Photograph 24). The water surface on the downstream side of 244th Avenue Northeast was at the crown of the outlet, and the pipe was flowing under pressure. The difference in hydraulic head across 244th Avenue Northeast was approximately 3.3 feet. The average slope of the flow path between Northeast 18th Street and 244th Avenue Northeast is approximately 0.26%. The capacity of the 24-inch 244th Avenue Northeast culvert likely backwaters the channel to upstream of Northeast 18th Street at the flow rate that occurred December 14, 2010.

6 Hydrology and Hydraulic Summary

6.1 Peak Flow Estimates

Results of HSPF and HEC-RAS modeling conducted by Northwest Hydraulic Consultants for Beaverdam Divisions 1 & 2 are tabulated in Table 1. These figures represent discharge from Allen Lake and reflect backwater effects and pool storage.

Table 1. Beaverdam Master Drainage Plan - Hydrologic Analysis 1997 – Allen Lake discharges.

	100-year peaks (cfs)	25-year peak (cfs)	2-year peak (cfs)
Existing conditions (1997)	14.6	12.6	7.0

6.2 Channel and Culvert Hydraulics

Land elevations flanking the channel on parcel 2625069054 are higher than land elevations upstream, toward Allen Lake. The topography of the land causes a distinct area of flooding from this parcel up to Allen Lake. At relatively higher flows, such as on December 14, 2010, water flow must funnel into the channel at this parcel and pass a series of culverts on downstream parcels.

The water surface elevation on this parcel and parcels up to Allen Lake during high flow rates reflects the amount of hydraulic head needed to push water through the series of culverts and the channel downstream.

Limited flow capacity at each of the driveway culverts downstream from parcel 2625069054 forms smaller areas of flooding. Limited flow capacity of the culvert under 244th Avenue Northeast appears to contribute to an area of flooding that is south of Northeast 18th Street,

and that may extend onto parcel 2625069010. The limited flow capacity of these culverts may be caused by obstruction by sediments, vegetation, beaver activity, and bar racks, and the capacity is ultimately limited by pipe size, length and material.

At relatively lower flows, such as on September 16, 2010, flow appears to be backwatered by high points in the channel on the parcels 2625069051 and 2625069054. The high points in this shallow reach are likely composed of hard glacial till. The effect of this backwater is to maintain the water surface elevation in the channel upstream and in Allen Lake.

The channel has a very shallow average slope from the Northeast 8th Street culvert to the 244th Avenue Northeast culvert, 0.0013 vertical foot/horizontal foot. Flow capacity tends to be low and sediment accumulation high on reaches that have shallow slope.

Table 2. Boulder Creek Apartments Rain Gauge.

Date	Precipitation (in.)	Date	Precipitation (in.)	Date	Precipitation (in.)
9/10/2010	0.00	10/20/2010	0.00	12/8/2010	0.90
9/11/2010	0.01	10/21/2010	0.01	12/9/2010	1.15
9/12/2010	0.00	10/22/2010	0.05	12/10/2010	0.01
9/13/2010	0.00	10/23/2010	0.38	12/11/2010	0.94
9/14/2010	0.00	10/24/2010	1.00	12/12/2010	2.73
9/15/2010	0.14	10/25/2010	1.49	12/13/2010	0.40
9/16/2010	0.34	10/26/2010	0.50	12/14/2010	0.65

6.2.1 Northeast 8th Street water surface control at low flow

Water begins to encroach on the south side of Northeast 8th Street at a water surface elevation of 339.10 feet. The downstream invert of the 30-inch corrugated polyethylene pipe (CPEP) culvert under Northeast 8th Street is at an elevation of 334.35 feet. The channel bottom downstream of the culvert rises to about 336.4 feet elevation near the property line between parcels 2625069052 and 2625069051 (station 3+10) and remains at about 336.0 feet elevation to the culvert on parcel 2625069054 (station 9+90). The elevation of the channel on this reach controls the minimum elevation of the water surface on the downstream side of Northeast 8th Street and on Allen Lake.

6.2.2 Northeast 8th Street water surface control at high flow

The crown of the access road above the culvert on parcel 2625069054 (station 9+90) is at about 341.7 feet elevation (Appendix D Frazier Culvert Replacement Plan (1995)), and the crown of Northeast 8th Street at the culvert is about 340 feet. At high flow rates, channel characteristics and the series of culverts from parcel 2625069054 backwater the upstream flow. This affects the water surface elevation at Allen Lake and on Northeast 8th Street.

6.2.3 Obstruction of Northeast 8th Street primary culvert

During the September 16, 2010 site visit, water on the upstream side of Northeast 8th Street was spilling through the overflow birdcage into the overflow catch basin. The birdcage rim controlled the upstream water surface elevation. The drop within the birdcage to the water surface was about 0.4 feet. The water surface elevation on the downstream side of Northeast 8th Street was also about 0.4 feet lower than the water surface elevation on the upstream side. Therefore, the 18-inch overflow culvert appeared to have adequate flow capacity for the flow that day. Since a 30-inch CPEP is capable of passing a much higher flow rate than was flowing that day, the primary culvert may have been obstructed.

6.2.4 Channel controls at parcels 2625069051 and 2625069054

At the time of the October 26, 2010 site visit, rainfall had been continuous for three days and flow in the outlet channel was greater than on the previous visit. The lower birdcage rim was fully under water and the land surface adjacent to the upstream channel was flooded. Water encroached on the south edge of Northeast 8th Street, west of the channel. The water surface elevation was the same on both sides of the road, indicating that a downstream control had backwatered the culverts and the lake. Water on the downstream side of Northeast 18th Street was about a 1.5 feet deeper than it had been on the September 16, 2010 visit.

The cause of a backwater at Northeast 8th Street appeared to be upstream of the driveway culvert on parcel 2625069091 (station 11+00), but control points between Northeast 8th Street and parcel 2625069091 were not observed on that day. At the higher flow rate on October 26, the channel upstream of the culvert on parcel 2625069091 may plainly have had lower flow capacity than the culverts at Northeast 8th Street. Additionally, new obstructions may have developed. Backwater effects from downstream likely affect the depth of water at the driveway culvert on parcel 2625069091 and contribute to backwater effects upstream.

6.2.5 Hydraulic head loss at driveway culverts

Observations made on December 14, 2010 reveal that the culverts on parcel 2625069054 (station 9+90), at the driveway on parcel 2625069091 (station 11+00), and at the driveway on parcel 2625069063 (station 14+70) contribute appreciably to backwatering the upstream channel, and land over the banks of the upstream channel, and to inundating Northeast 8th Street.

Hydraulic head fell approximately 0.7 foot through the culvert on parcel 2625069054. Immediately downstream at the driveway culvert on parcel 2625069091, hydraulic head fell approximately 1.8 feet. The driveway on parcel 2625069063 was overtopped and the difference in water surface elevation across this driveway is estimated to be 0.8 foot. About 3.3 feet elevation of water surface was held back across these culverts. The depth of flow in the channel at its highest points across parcel 2625069051 and onto parcel 2625069054 (from station 3+20 to station 9+75) was about 4 feet and was over the banks.

All three of these culverts are 36-inch pipe. The driveway culverts on parcels 2625069091 and 2625069063 are corrugated metal pipe, and the culvert on parcel 2625069054 is corrugated polyethylene pipe.

The invert of the 36-inch driveway culvert on parcel 2625069063 was surveyed at 331.6 feet elevation (RW Beck, 1995) and the channel invert 460 feet downstream (at station 19+30) was surveyed at 333.4 feet elevation. That is a 1.8 foot downstream increase of the stream bed elevation. This downstream rise in the channel may dispose the driveway culvert and channel reach on parcel 2625069063 toward sediment accumulation, reducing the flow capacity of the culvert. Limited flow capacity of this driveway culvert may backwater the driveway culvert on parcel 2625069091, causing sediment accumulation at that culvert and reducing flow capacity.

The driveway culvert on parcel 2625069010 (station 18+50), like the driveway culvert on parcel 2625069063, has an adverse downstream slope (0.9 foot rise) and may be prone to sediment accumulation, albeit to a lesser degree.

6.2.6 Theoretical flow capacity of culvert series

Nomographs (Figure 20 and Figure 21) are used to evaluate how much hydraulic head loss to expect from these culverts if they were unobstructed. The series of culverts from Northeast 8th Street to the driveway culvert on parcel 2625069010 can be expected to cause a head loss of about 3.85 feet at a flow rate of 30 cubic feet per second (cfs). This assumes energy loss due to projecting inlet configurations and it assumes the culverts are clear of obstruction. This depth does not account for friction losses in the channel. The larger losses (0.9 foot) are at the driveway culverts on parcels 2625069091, 2625069063, and 2625069010. The smallest loss (0.5 foot) is at the culvert on parcel 2625069054. The hydraulic head loss at the Northeast 8th Street culverts would be about (0.65 foot).

The theoretical hydraulic head loss was applied to elevations on Northeast 8th Street in order to compare it with conditions observed on December 14, 2010. If the series of culverts were outlet controlled (downstream end submerged) at thirty cubic feet per second, the water surface elevation on the downstream side of Northeast 8th Street would be at least about 338.7 feet. Water would encroach on the eastbound side of Northeast 8th Street. In fact, the water surface at Northeast 8th Street was at not less than about 339.7, much higher than expected if the culverts were unobstructed.

On December 14, 2010, the 24-inch culvert under 244th Avenue North east was outlet controlled with a hydraulic head loss of about 3.3 feet from the inlet to the outlet. Assuming that head loss at a catch basin midway along the culvert is minor, the culvert was carrying as much as 26 cfs (Figure 22). There are inflows to the Allen Lake outlet channel downstream from parcel 2625069010 that would contribute to this flow rate, so the flow rate in the series of driveway culverts was likely less than 26 cfs.

Considering that there were several inches of water on Northeast 8th Street and that the flow rate through the culvert on parcel 2625069054 was not likely more than 26 cfs, it appears that the driveway culverts are passing less flow than their size and materials would allow.

Channel friction or impaired culvert capacity has to account for a hydraulic head loss of about one foot, in a distance of about 1,000 feet, to match the observed water surface elevation if the flow rate were 30 cfs that day. The flow rate was likely less than 30 cfs, indicating that the actual head loss due to channel friction and impaired culvert capacity was likely greater than one foot.

6.2.7 Backwater above 244th Avenue Northeast

The depth of water at the inlet to the 244th Avenue Northeast culvert on December 14, 2010 was about 4.2 feet. The channel slope from the culverts at Northeast 18th Street and 247th Place Northeast to the culvert at 244th Avenue Northeast is 0.17 percent (0.0017 horizontal foot/vertical foot).

The difference between water surface elevation at the two ends of the Northeast 18th Street culvert was not measureable with a hand level, so the upstream water surface is controlled by channel friction and backwater effects from downstream of the culvert.

Although an obstruction other than channel friction may be present in the channel between 247th Place Northeast and 244th Avenue Northeast, it is likely that limited flow capacity of the culvert under 244th Avenue Northeast and channel friction contribute appreciably to flooding south of Northeast 18th Street because the downstream channel slope is very small.

7 Hydraulic Summary

Annual flooding on Northeast 8th Street appears to be caused primarily by limited flow capacity in a series of four privately owned culverts off 250th Avenue Northeast. Based on rainfall depths prior to site visits for this study, two to three inches of rainfall in a week may cause water encroachment on Northeast 8th Street; five inches of rainfall in a week may cause flooding about one foot deep on Northeast 8th Street.

The first of the four downstream culverts (Frazier Culvert, page 26) was replaced by King County in 1995 to enlarge it from 24 inches to a 36-inch diameter corrugated polyethylene pipe. The next three culverts are 36-inch diameter and constructed with corrugated metal pipe. Corrugated metal pipe typically causes more hydraulic head loss than corrugated polyethylene pipe.

Channel slope, sediment accumulation, and presence of barriers such as bar racks or beaver dams each likely contributes to diminished flow capacity in the culverts. The elevations at which two of the corrugated metal culverts are installed may make all three prone to sediment accumulation due to adverse channel slopes and backwater effects.

Two corrugated polyethylene culverts were installed under Northeast 8th Street as part of the Frazier culvert replacement. The primary 30-inch culvert at Northeast 8th Street appears to be obstructed by sediment and vegetation.

A 24- inch culvert under 244th Avenue Northeast conveys discharge from Allen Lake and other inflows to the stream. The limited flow capacity of this culvert causes a backwater which may affect flooding on properties along 250th Avenue Northeast.

8 Alternatives

The following alternatives are suggested for consideration under a feasibility study and are not prioritized in any way. These focus primarily on different parts of the outlet channel and can be implemented in combination. Alternatives considered under a feasibility study do not need to be limited to this list. Hydraulic modeling of the channel is recommended to evaluate the effectiveness and consequent effects of alternatives.

Alternative 1 Clean Northeast 8th Street culvert and stabilize banks on upstream channel

Cleaning the primary culvert at Northeast 8th Street would likely allow low flows to pass the culvert controlled by the downstream channel elevation. This may be a matter of clearing debris from a bar rack on the primary culvert. It may require dewatering a portion of the channel to remove sediment from inside the culvert. Depending on the channel profile near this culvert, dredging material from the channel may be needed to reduce the frequency of maintenance cleaning. If bank sloughing is evident, bank stabilization is recommended. Installation of a beaver deceiver may reduce the likelihood this inlet becomes clogged.

This alternative alone is not expected to reduce flooding at high flows.

Alternative 2 Raise Northeast 8th Street and replace culverts

Raising Northeast 8th Street and providing adequate conveyance past Northeast 8th Street would likely reduce flooding on the street.

Raising the road with shoulders that meet road standards may impact adjacent wetlands.

Alternative 3 Replace and raise driveway culverts at parcels 2625069063 and 2625069010

The inverts of these culverts are below the invert of the downstream channel. This likely causes them to be prone to sediment accumulation, which may obstruct flow. A backwater caused by the driveway culvert at parcel 2625069063 likely causes the driveway culvert at parcel 2625069091 to be prone to sediment accumulation. Hydraulic head loss through this series of culverts appears to be the primary cause of flooding on Northeast 8th Street, as well as on some of these properties.

Alternative 4 Replace and enlarge culvert under 244th Avenue Northeast at Northeast 22nd Street

Flooding between parcel 2625069010 and Northeast 18th Street at high flows appears to be caused by limited flow capacity in the culvert under 244th Avenue Northeast and by channel friction due to vegetation. Increasing the capacity of this culvert may reduce the likelihood that the driveway culvert at parcel 2625069010 becomes backwatered and therefore may reduce the water surface elevation at Northeast 8th Street. Beaver activity in this reach could reduce the benefits of culvert replacement. Properties downstream from 244th Avenue Northeast would likely be affected by an increase the capacity of the culvert.

Alternative 5 Regrade channel on parcels 2625069051 and 2625069054 and lower the culvert on parcel 2625069054.

Dredging the channel immediately downstream from Northeast 8th Street may reduce channel friction due to geometry. Reducing the elevation of the channel invert would reduce the elevation of the water surface at the Northeast 8th Street culvert allowing better access for cleaning. However, the elevation of the channel invert on these parcels also establishes the minimum elevation of the water surface in Allen Lake during low stream flow. Regrading this reach of channel would lower the water surface elevation on a Category 1 wetland unless the water surface were otherwise controlled.

Alternative 6 Regrade channel from parcel 2625069066 to Northeast 18th Street

Dredging the channel upstream from Northeast 18th Street may reduce channel friction due to geometry and would lower a control that may contribute to flooding on properties upstream. This is likely the alternative least apt, on its own, to reduce flooding on Northeast 8th Street. Access to the channel in this reach may cross wetlands.

9 Summary

This rapid assessment report describes and analyzes the capacity of the Tributary 0111A (Allen Lake outlet channel) to convey expected flows. The alternatives listed above are suggested for consideration under a feasibility study. These alternatives focus primarily on different parts of the outlet channel and can be implemented in combination. Alternatives considered under a feasibility study do not need to be limited to this list. Hydraulic modeling of the channel is recommended to evaluate the effectiveness and consequent effects of alternatives under the feasibility study. The feasibility study will determine the feasibility of capital improvements or determine preferred alternatives to forward to funding in the capital improvement six-year plan.

Appendix A **Charts and Diagrams**

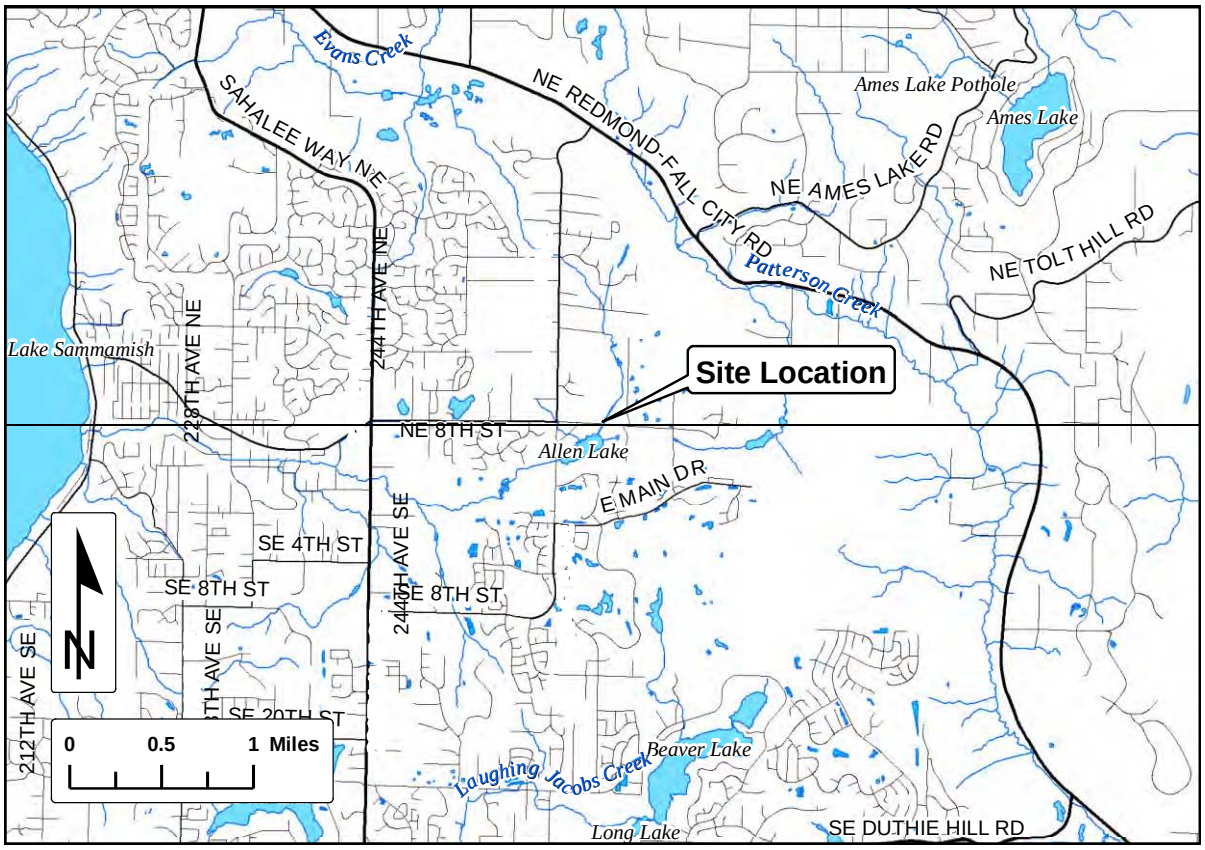


Figure 1. Vicinity Map

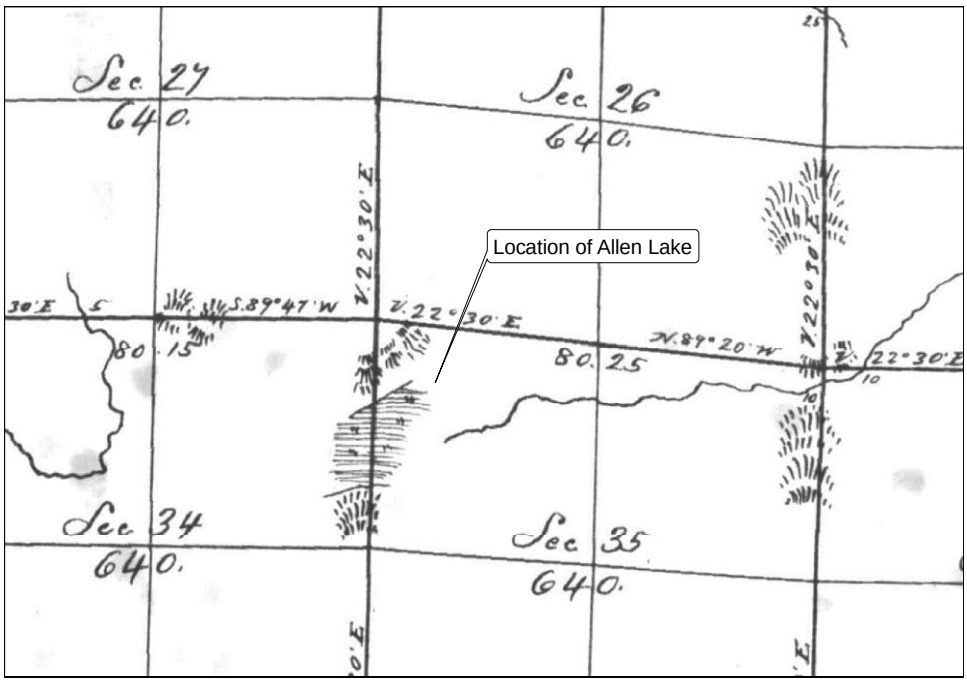


Figure 2. General Land Office map detail (surveyed March 1874)

Figure 3. Approximate stationing in feet downstream from the centerline of Northeast 8th Street.

Figure 4. Locations of parcels and photograph points - Allen Lake.

Figure 5. Locations of parcels and photograph points - channel adjacent to 250th Avenue Northeast.

Figure 6. Locations of parcels and photograph points - downstream from 250th Avenue Northeast.

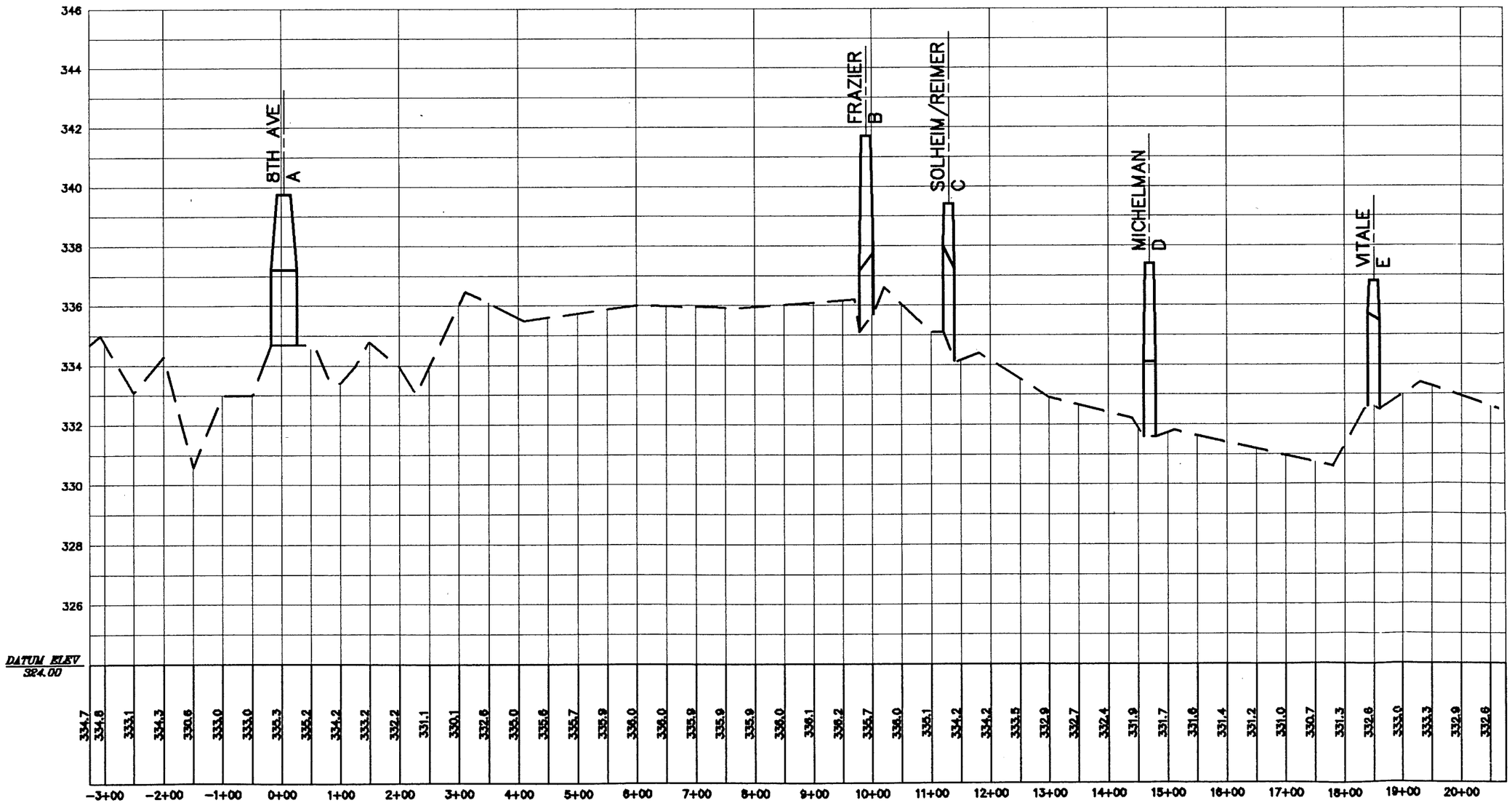


Figure 7. Outlet channel profile (RW Beck, Apr-May 1995) - 8th Avenue Northeast to parcel 2625069010.

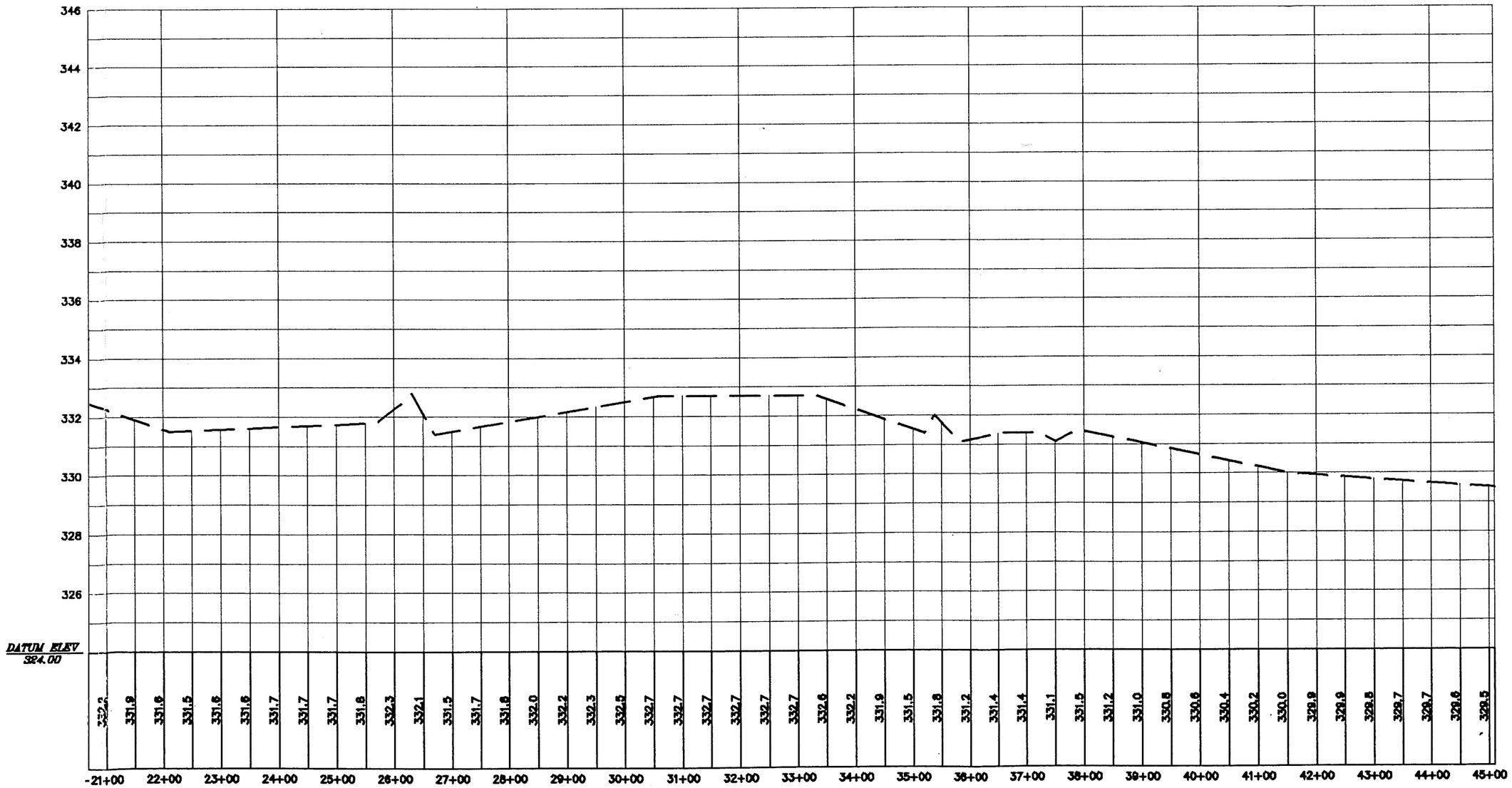


Figure 8. Outlet channel profile (RW Beck, Apr-May 1995) - parcel 2625069010 to near current boundary of the City of Sammamish at Haney property.

Appendix B **Northeast 8th Street Culvert Replacement Plan**

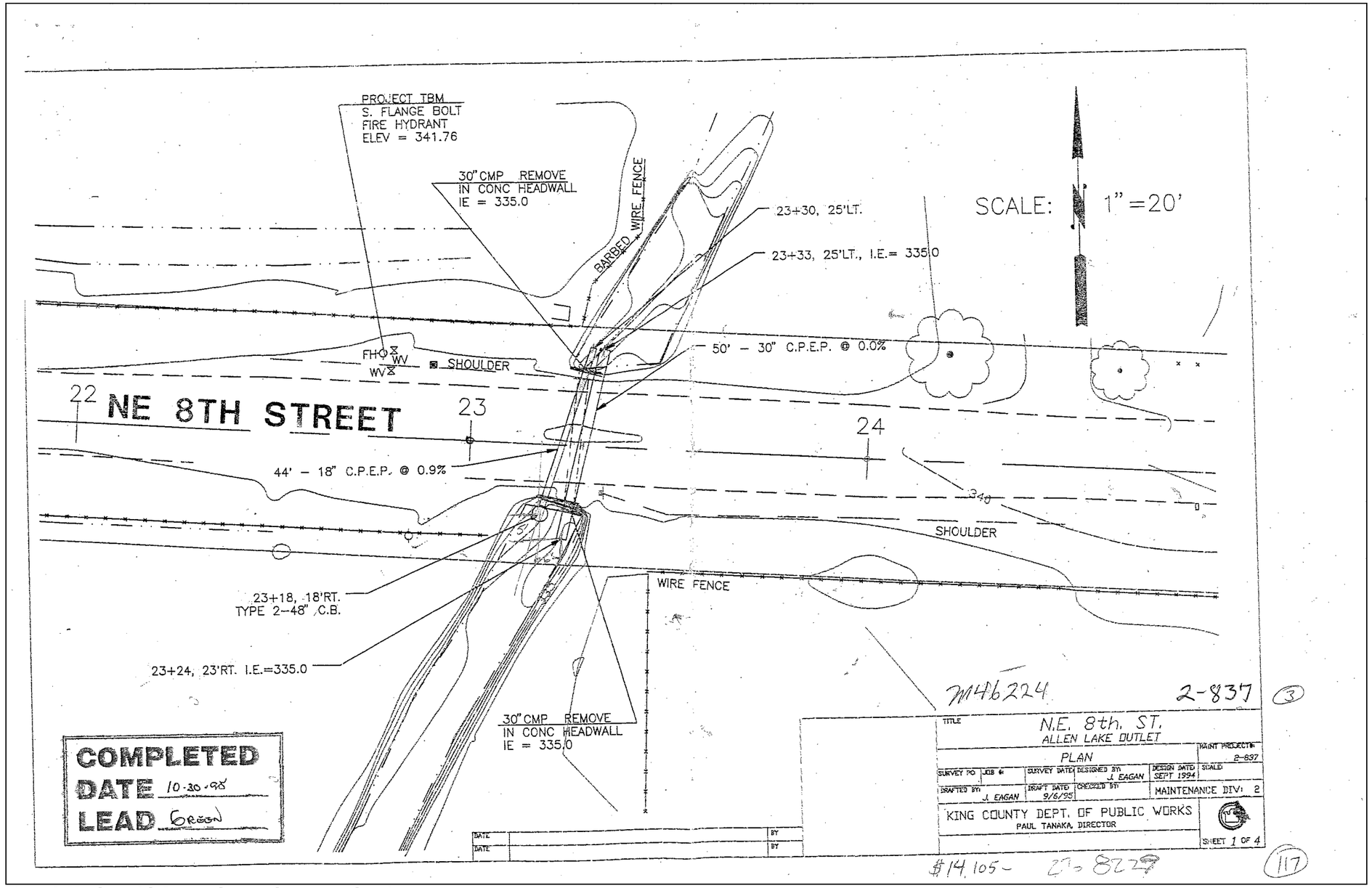


Figure 9. Northeast 8th Street culvert replacement - plan view.

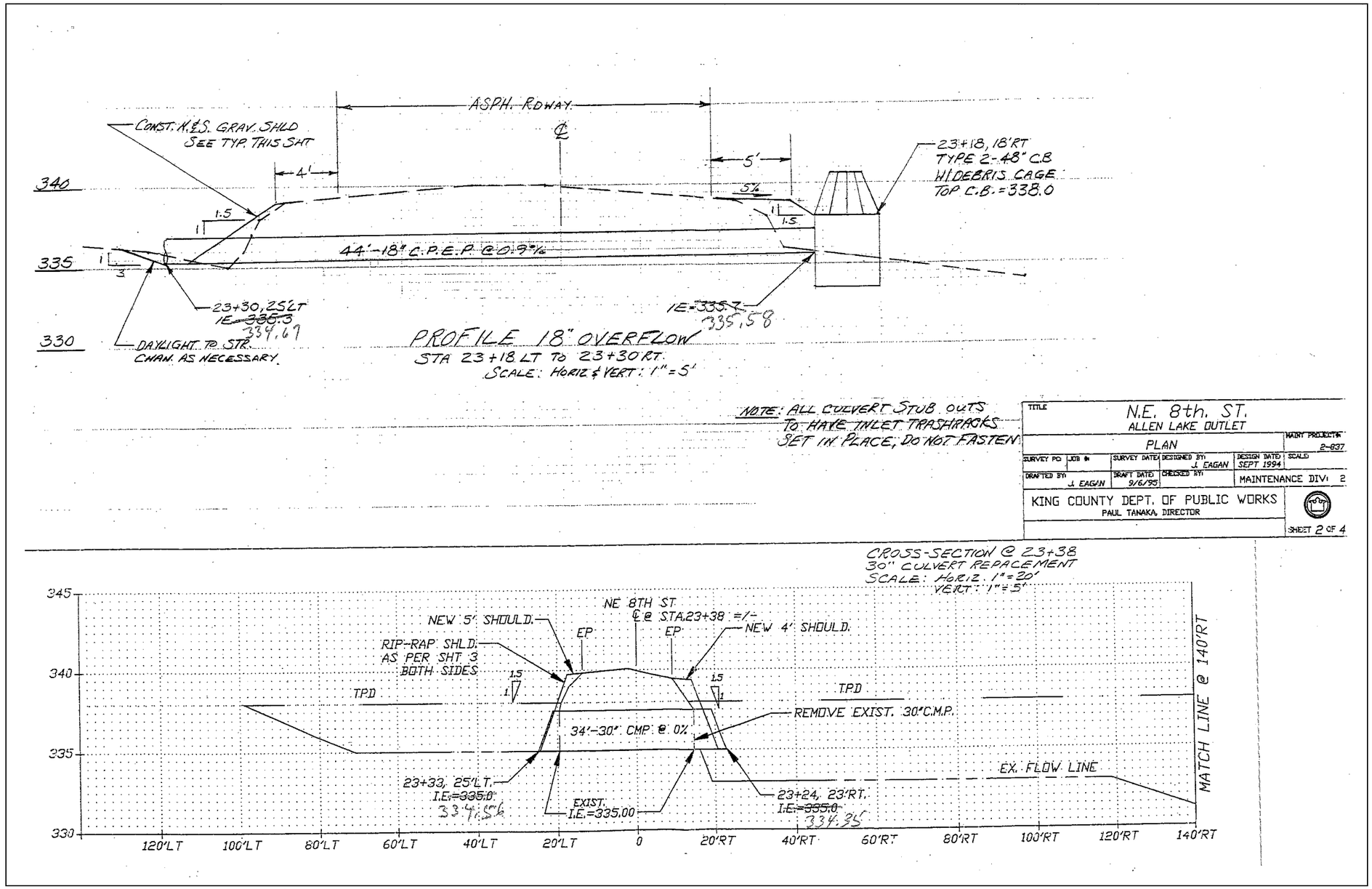


Figure 10. Northeast 8th Street culvert replacement - profiles.

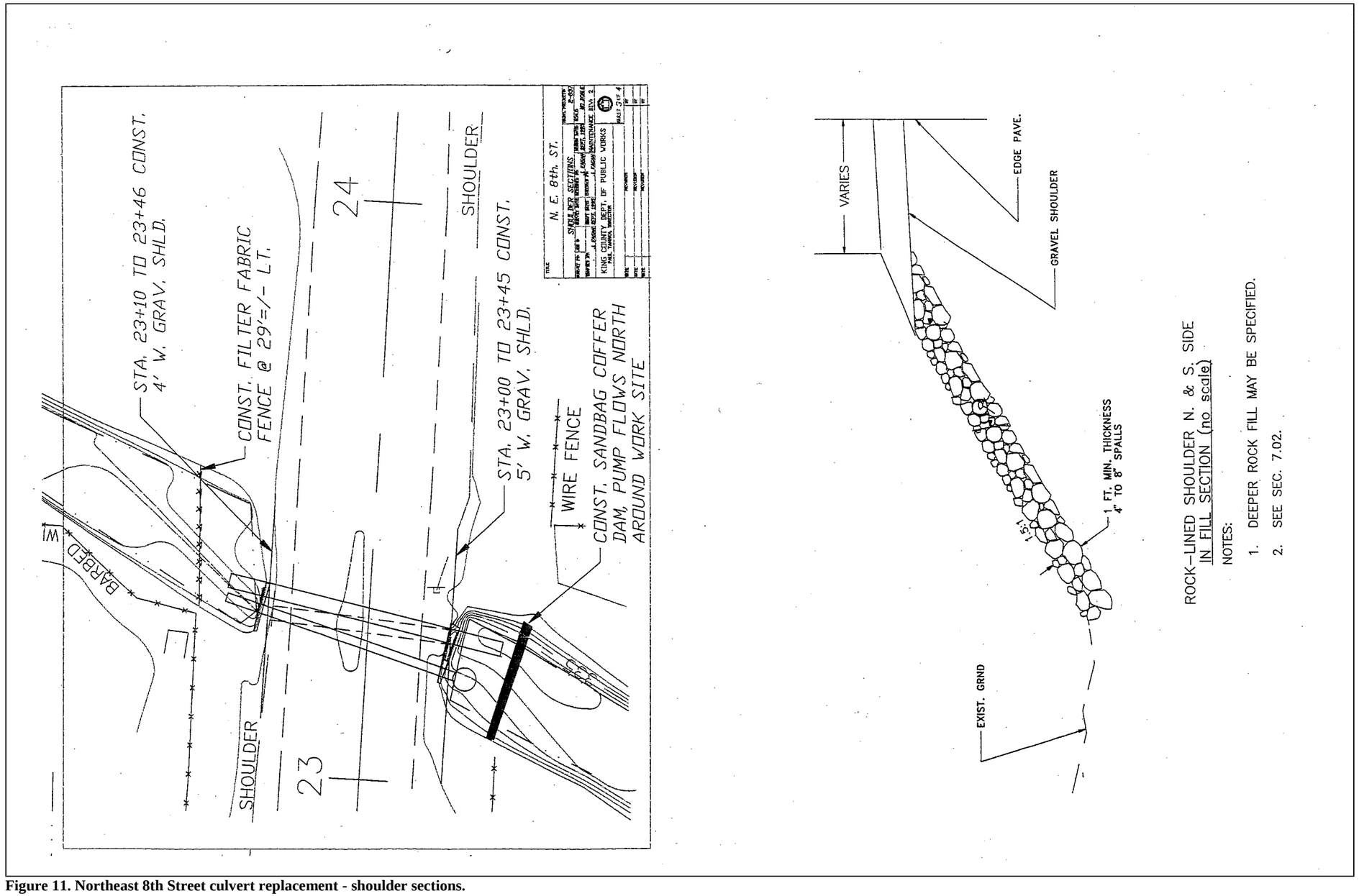


Figure 11. Northeast 8th Street culvert replacement - shoulder sections.

Appendix C **Northeast 8th Street Culvert Maintenance BMPs**

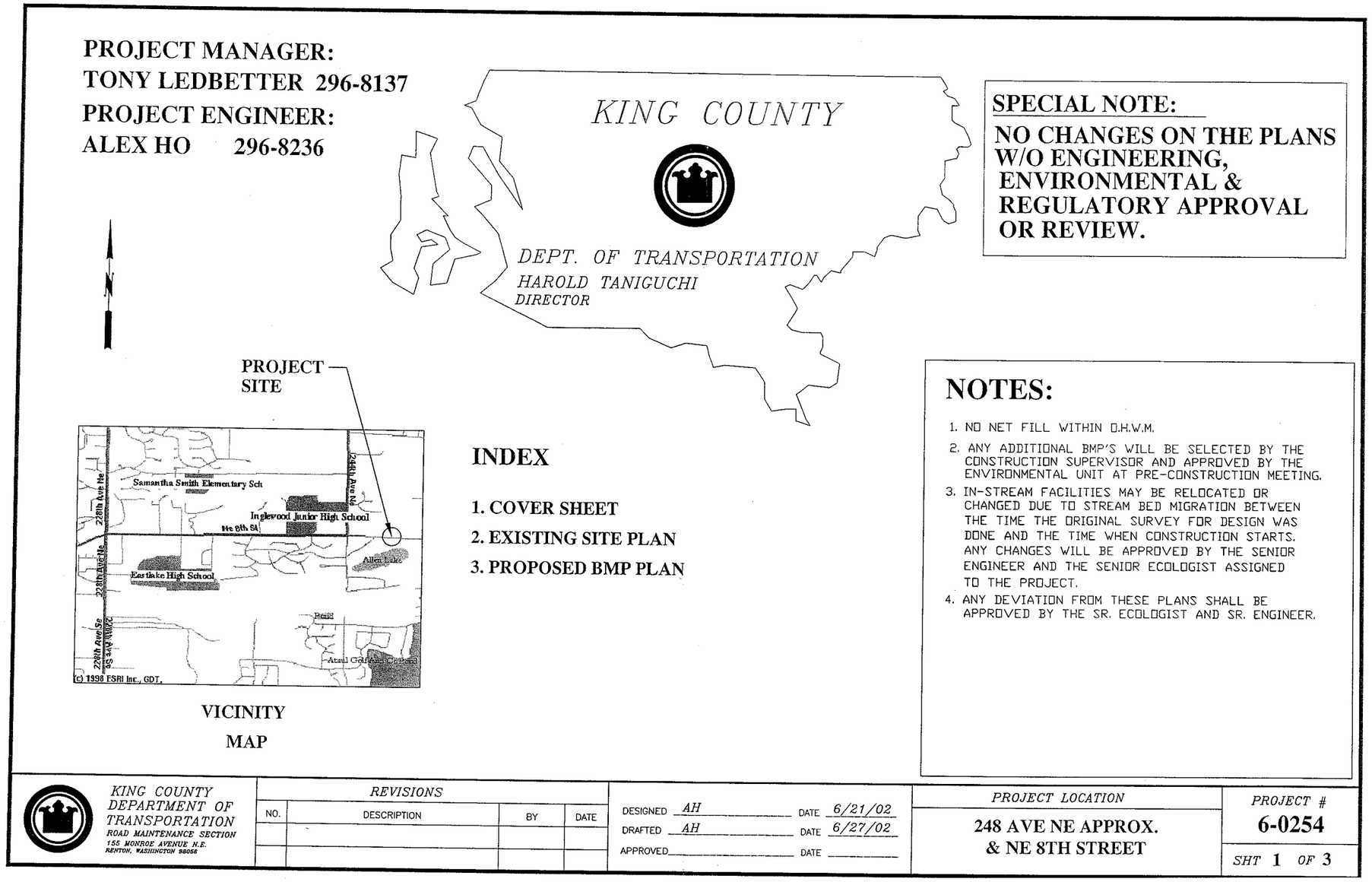


Figure 12. Northeast 8th Street maintenance plain - coversheet.

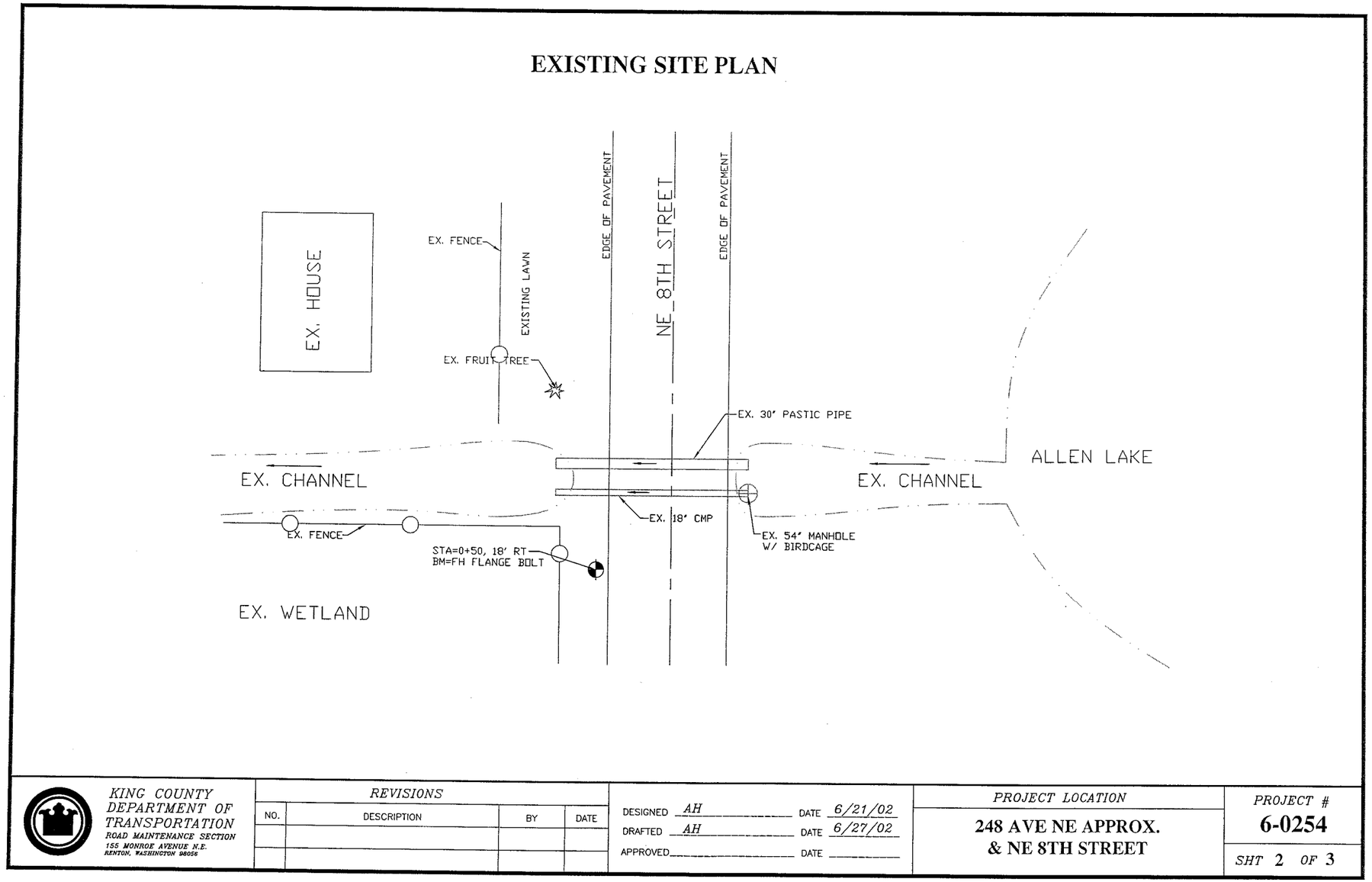


Figure 13. Northeast 8th Street maintenance plan - existing site plan.

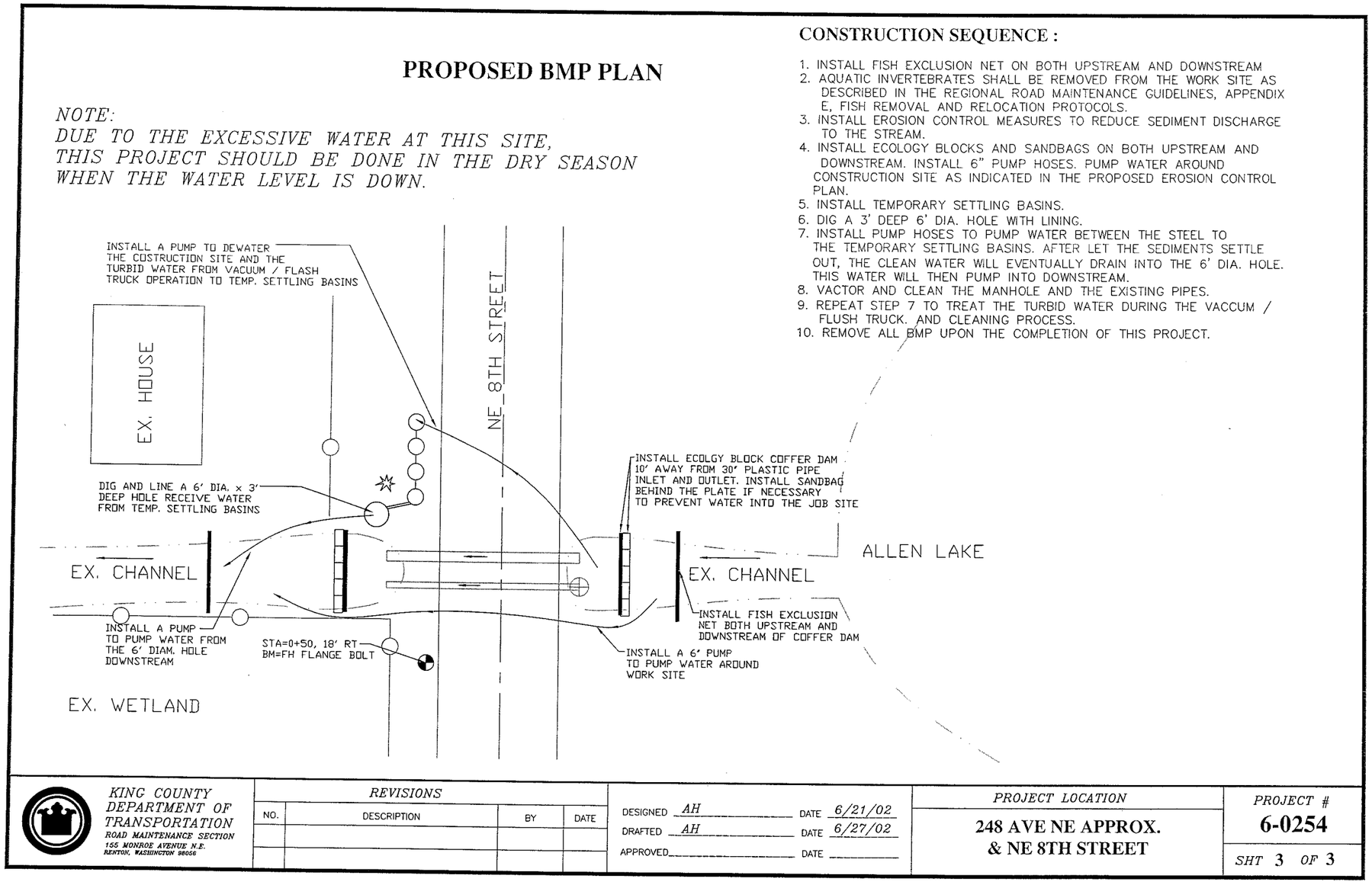


Figure 14. Northeast 8th Street maintenance plan - proposed BMP plan.

Appendix D **Frazier Culvert Replacement Plan (1995)**

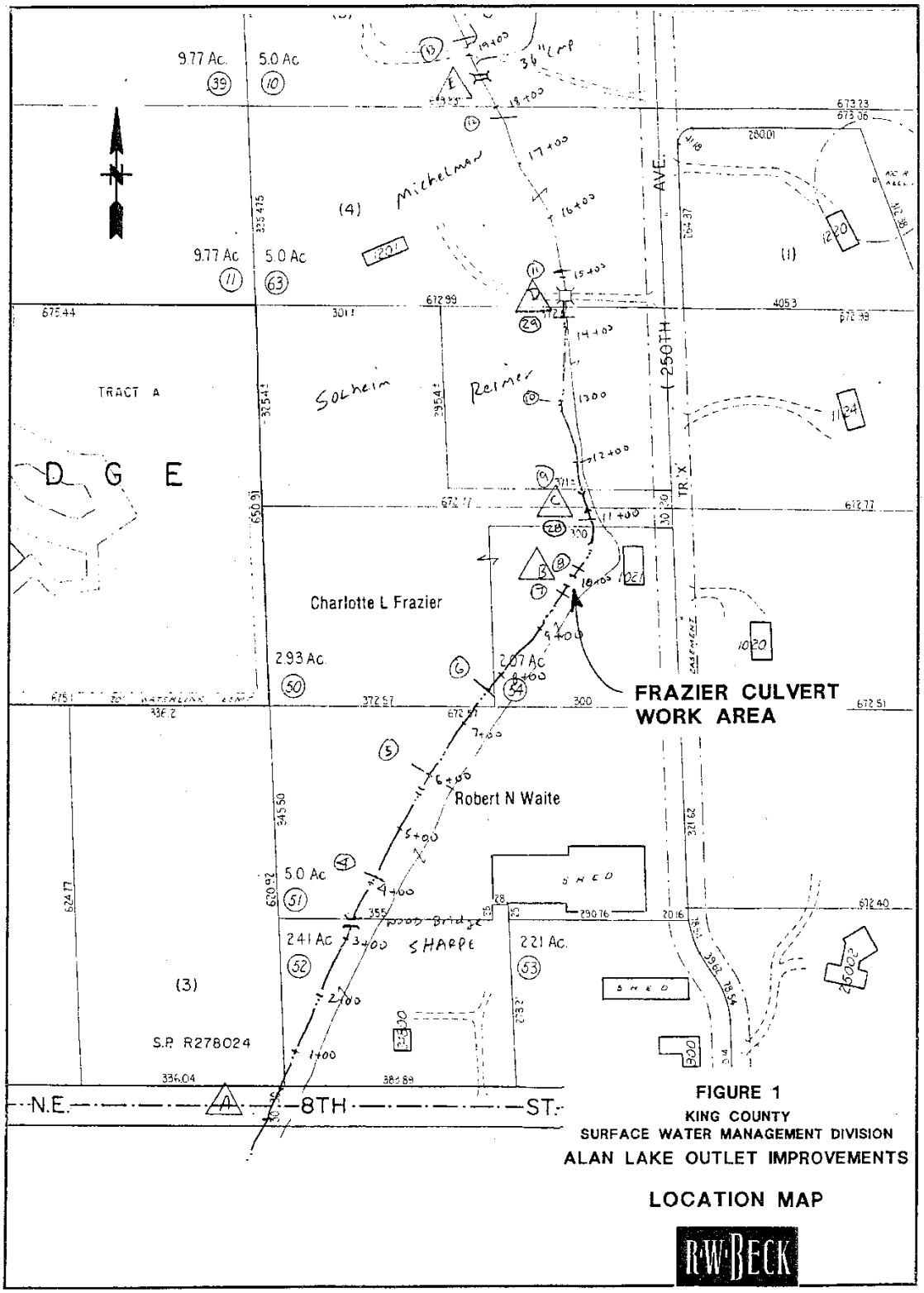


Figure 15. Site location of Frazier culvert replacement.

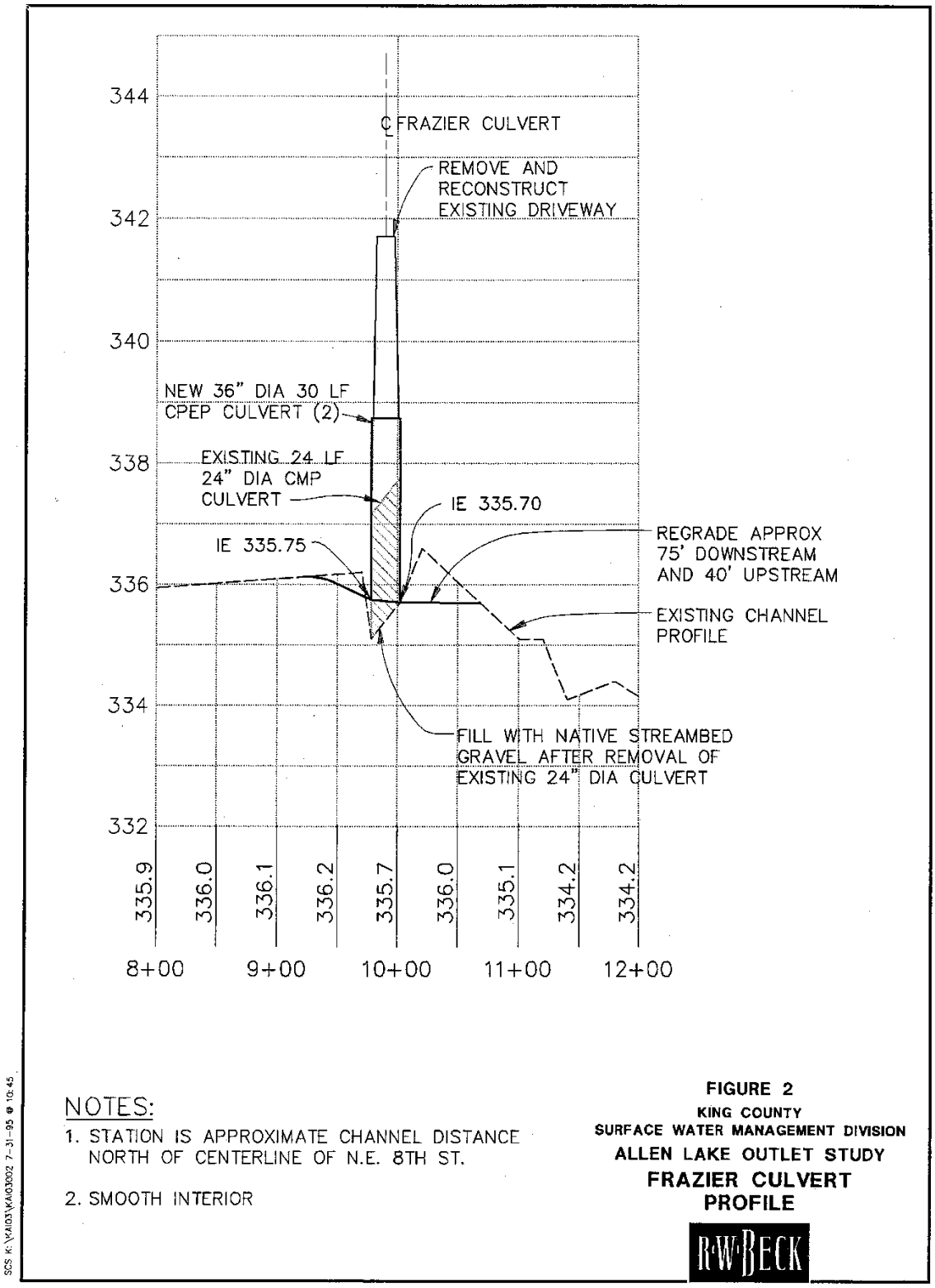


Figure 16. Profile of Frazier culvert replacement.

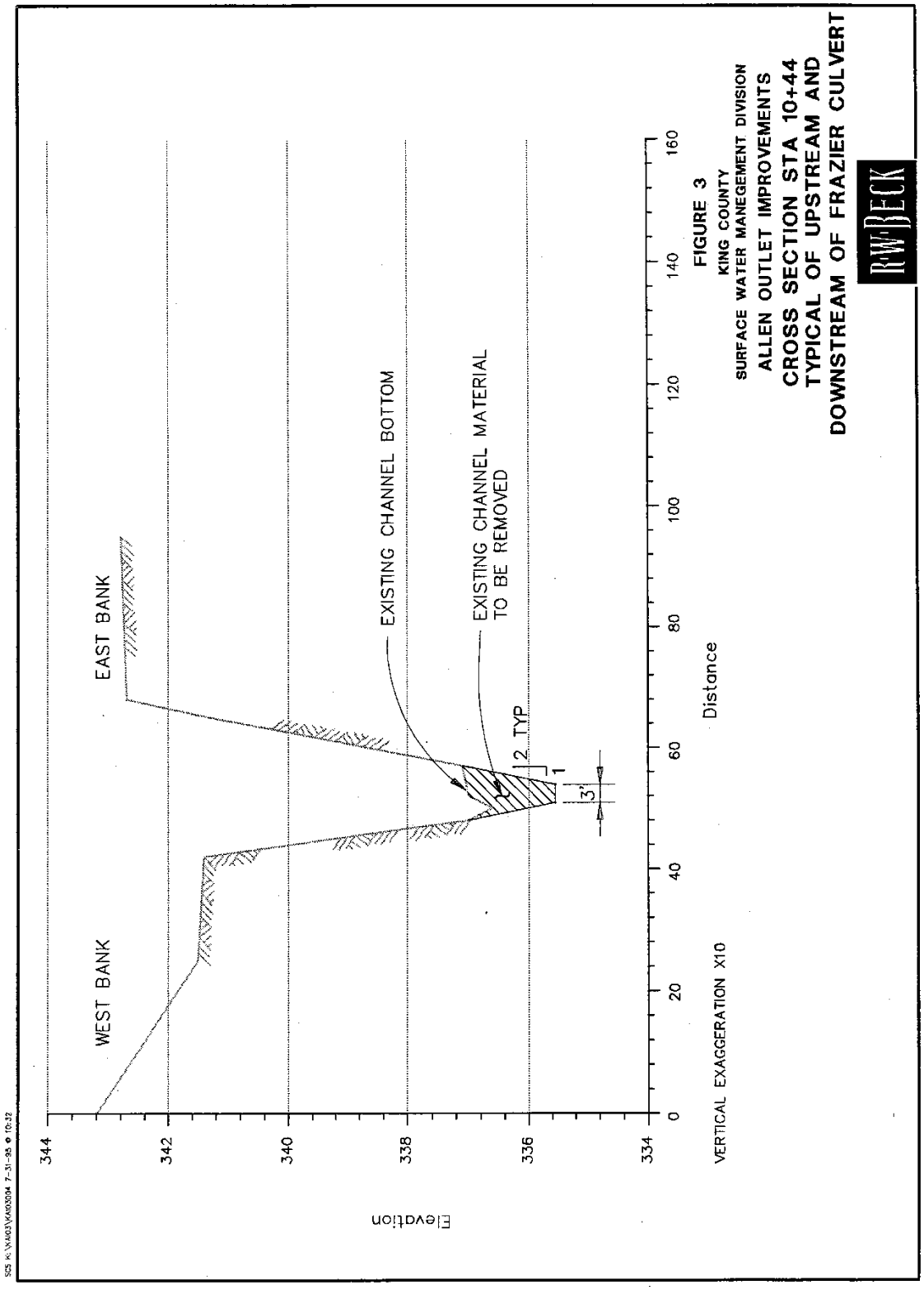


Figure 17. Cross-section of Frazier culvert replacement.

Appendix E **Camden Park Storm Drainage Plan Detail**

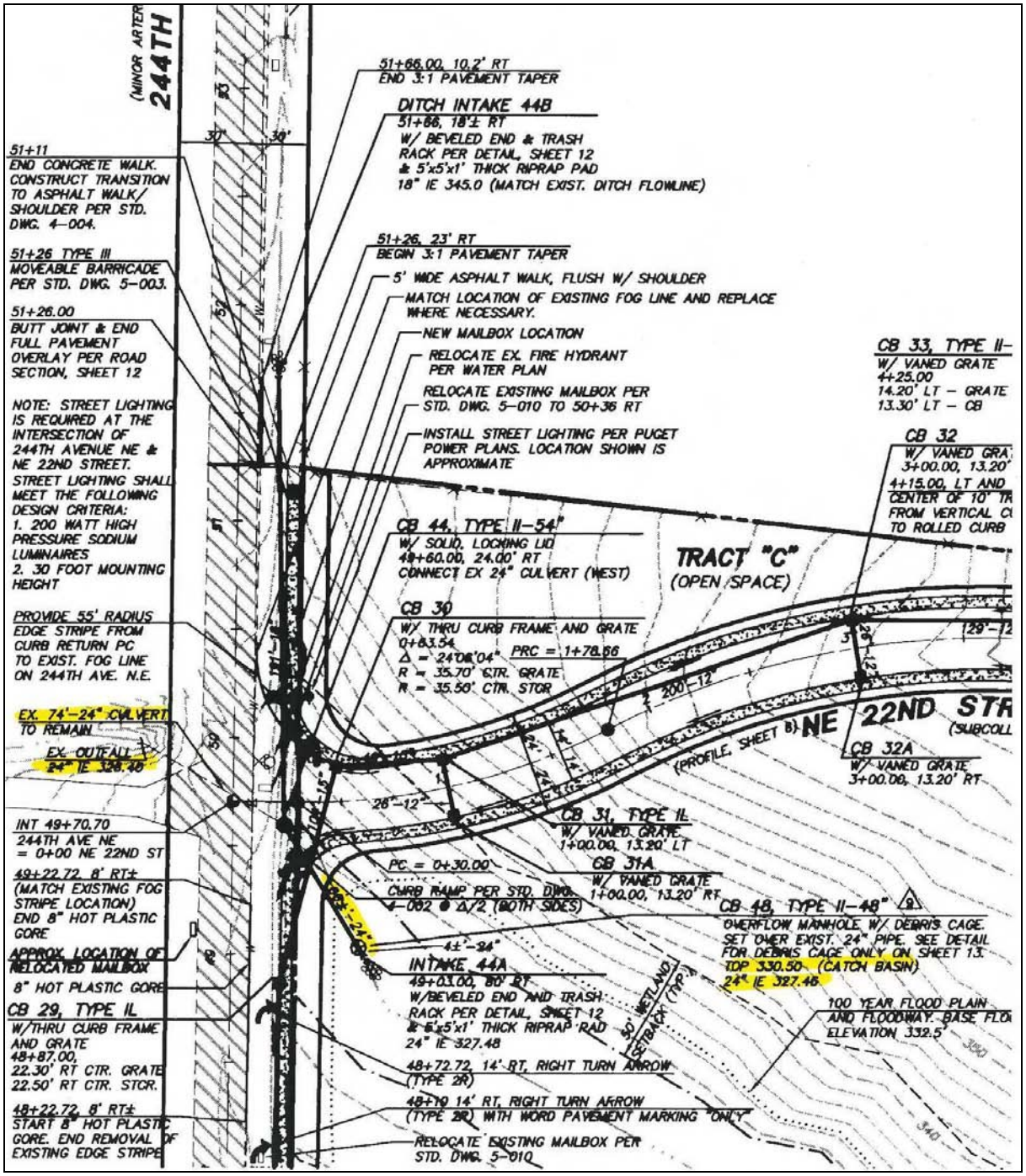


Figure 18. Camden Park Drainage Plan detail.

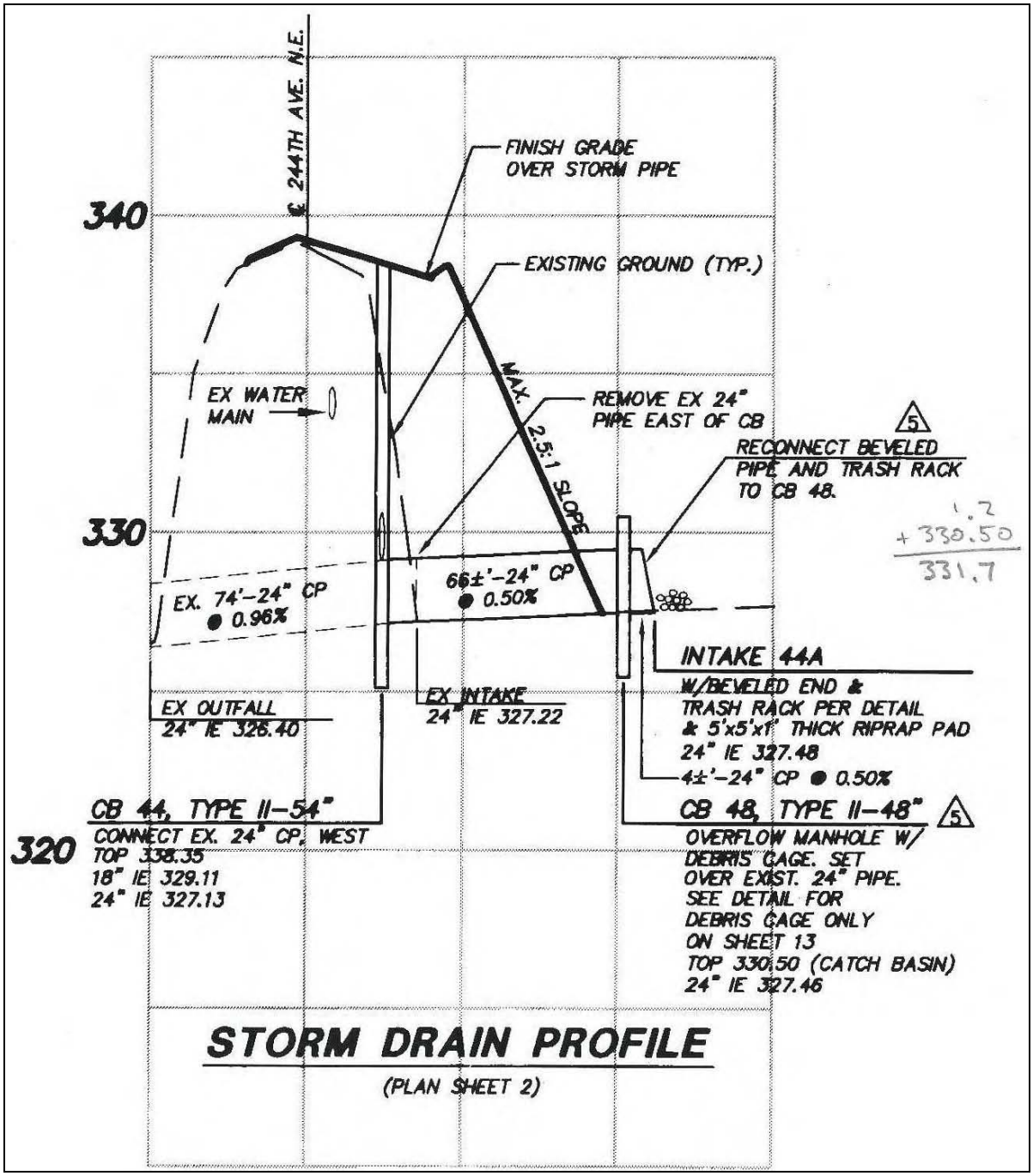


Figure 19. Camden Park: profile of 24 in. culvert extension at 244th Avenue NE.

Appendix F **Site Visit Photographs**

Photograph 1. Channel upstream from Northeast 8th Street.

Photograph 2. Channel downstream from Northeast 8th Street.

Photograph 3. Northeast 8th Street west of outlet channel.

Photograph 4. Bird cage on upstream side of Northeast 8th Street.

Photograph 5. Channel upstream from near Unger south property line.

Photograph 6. Channel downstream from near Unger south property line.

Photograph 7. Channel on upstream side of Roome/Reimer driveway.

Photograph 8. Channel on downstream side of Roome/Reimer driveway.

Photograph 9. Channel on upstream side of Vitale driveway.

Photograph 10. Channel on downstream side of Vitale driveway.

Photograph 11. Channel upstream near northwest corner of parcel 2625069066 .

Photograph 12. Channel downstream near northwest corner of parcel 2625069066 .

Photograph 13. Culvert under Northeast 18th Street - upstream view.

Photograph 14. Channel downstream at Northeast 18th Street.

Photograph 15. Inlet to 24" culvert under 244th Avenue Northeast.

Photograph 16. Flooding on Northeast 8th Street December 14, 2010.

Photograph 17. Flooding over channel banks on Lucarelli property December 14, 2010.

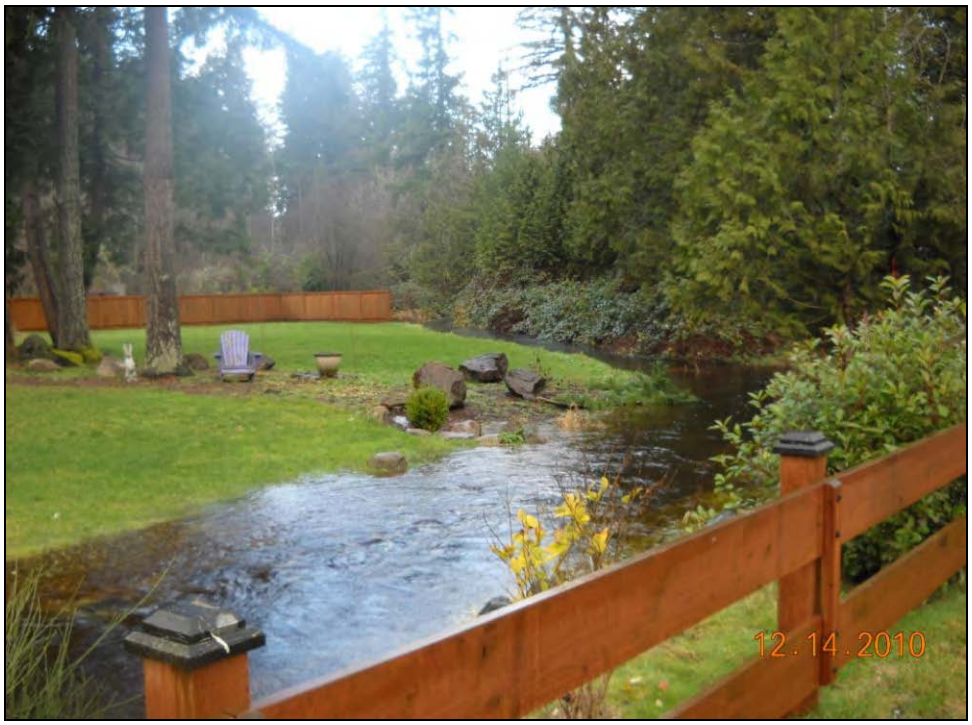
Photograph 18. Location of 36 inch culvert on parcel 2625069054.

Photograph 19. Reimer/Roome 30" culvert backwatering parcel 2625069054.

Photograph 20. Parcel 2625069049 partially inundated.

Photograph 21. Michelman culvert backwatering parcel 2625069049.

Photograph 22. Parcel 2625069010 partially inundated.



Photograph 23. Channel flowing bank full downstream from 247th Place Northeast.

Photograph 24. Inlet to 244th Avenue Northeast culvert December 14, 2010.

Appendix G **Activity Log**

Date	Task Description
9/2/10	Site visit with Claire Jonson - observed that bar rack on upstream end of NE 8th Street culvert appeared obstructed by aquatic vegetation/ sediments - upstream water level was below rim of bird cage - channel was backwatered such that crown of culvert was submerged - viewed channel downstream, water was dense with vegetation, no firm obstructions visible from road - checked 30" culvert under driveway to 1125 250th Ave NE - reed canary grass thick in channel, but culvert otherwise clear - flow on floor of culvert only - met resident at 1021 250th Ave NE (Unger) - she said that field at 1117 250th Ave NE floods almost annually - gave permission to observe channel on her property - vegetation/sediments in channel at SW corner of her property controlled flow - surface upstream was slack - no further obstructions observed - left card on door of 905 250th Ave NE (Lucarelli) - observed channel at driveway for 1201 250th Ave NE - thick with reed canary grass and some blackberry - observed ditch on east side of 250th - water table expressed at surface in ditch - observed channel at driveway for 1319 250th Ave NE - channel well maintained, clear, partially armored, extensive landscaping, some stream flow pumped to adjacent lake with no surface connection, lake surface elevation a little higher than stream surface - attempted contacting resident, no answer at door - attempted contact at 1525 250th Ave NE - no answer at door - channel towards back of property - not observed - approached stream from right of way on NE 16th Street - depth to vegetation very shallow - flow is low, choked - channel thickly wooded downstream - observed channel at NE 18th Street - channel not discernable upstream in wooded, shrubby area - downstream channel deeply cut, thick with reed canary grass, banked with bramble.
9/6/10	Received phone call from Mike Lucarelli (905 250th Ave NE) - he described what he believed to be a beaver dam in the channel near his north property line - he had seen no beavers, but had heard of them in the area - he said 8th Street has water on it annually and vegetation in the channel has become fairly thick - I asked him about the water surface in the channel and he answered that there is no place on the channel on his property where the water surface drops across an obstruction.
9/16/10	I met Diane Denman at the site requesting to have the primary inlet cleared. She thought that a vactor might be overwhelmed by water before removing material from inside the catch basin. She offered to see if her crew could clear vegetation from the outside of the catch basin. She later called me to say a crew from division one would attempt work on it the next morning. At the site I spoke with Jim Engman, who was working for Linda McCoy. Ms. McCoy lives on 8th on the east side of the stream. Jim said that water had flowed into her basement twice in the last four years and that she had a pump installed. I gave him my card and asked that Ms. McCoy contact me with a description.
9/23/10	I stopped by the culvert under NE 8th St. because I was nearby. Grass, mud, and other material had been packed around the base of the bird cage. I left a message for Dianne Denman that beavers were apparently working on this outlet and that roads maintenance may want to keep an eye on it.
9/24/10	Diane returned my call and said they'd keep an eye on the bird cage.

Date	Task Description
10/7/10	I went to roads engineering in Renton and made partial copies and notes regarding work conducted or planned at the culvert under NE 8th Street. Drainage tracker numbers 2-837, 6-0254, and 2-1423 are pertinent. 2-837 shows a culvert replacement that was completed in October 1995 and includes a downstream profile of the stream. A 30" CMP was replace with a 30" CPEP and an 18" CPEP that is connected to the birdcage only, as overflow only with no lower inlet. 6-0254 is a set of BMPs drawn up in 2002 and used to clean the pipes by dewatering the stream. 2-837 is a conceptual plan to raise the road elevation. I spoke with Jon Cassidy regarding the projects. He said that 2-837 is on hold. Raising the road would widen the road prism, impacting existing wetland. Mr. Cassidy said that roads does not have funds for property acquisition that would be needed for mitigation. He expected that a 10' or 12' box culvert would replace the existing culverts and that additional cross culverts would be included in a raised road.
10/7/10	I spoke with Jim Eagan, the design engineer for 2-837. He had told Brian Sleight that a perforated pipe extending into the channel was considered for a beaver deciever at this site. Mr. Eagan told me that no such perf pipe was installed at this location. He told me that the bird cage was intended as overflow to protect the roadway in case the 30" pipe were clogged. He said that raising the road was considered, but that potentially raising the surface of the lake was not considered acceptible.
10/26/10	Visited site with R. Berryessa and C. Jonson. Water encroaching on south shoulder of 8th Street, land south of 8th flooded over bank of channel. Bird cage had been kept clear of debris and its rim was submerged. Water surface elevation was the same on both sides of 8th. Downstream at 30" culvert under driveway to 1125 250th flow in channel was deep but fairly swift through reed canary grass and aquatic vegetation.
10/27/10	Left message for Linda McCoy at 24800 NE 8th St (Happy Hound Hotel) (425) 522-4848. Requested call back regarding water in basement.
10/28/10	Spoke with Ms. McCoy. She said that water in the channel has remained high recently. Even after 6 days without rain last week, the water surface was up to the bridge on her property. She said her basement, including some living space has been flooded 5 times in the last three years. She said that water comes up from the foundation.
11/14/10	Site visit to observe pinch points - NE 8th Street inundated 9/10ths of a foot at crown - Spoke w/ Linda McCoy, Mike & Renee Lucarelli, Jim Unger, & Joe Bookter. Met Larry Herrick & Carol Nadalin while speaking with Mr. Bookter. Ms. McCoy was concerned by mold in home and damage. The Lucarellis gave permission for me to enter their property - I observed flooding over banks of the stream, but no definite obstruction. Mr. Lucarelli said water on 8th was up to the hub on his truck - about 14 in. Mr. Lucarelli also said that he dredged the stream some at the request of an upstream neighbor when he first moved to the property, but was informed that the activity required a permit and did not dredge further. Mr. Unger gave permission for me to enter his property. Flood area narrowed and went within banks of stream on Unger property due to topography. Location of concentrated flow was difficult to discern as flood area narrowed - thick vegetation over channel likely causes minor head losses. Culvert on Unger property reduced head about 0.7 foot. Driveway to Reimer/Room properties reduced head about 1.8 foot. Reimer yard was flooded. Michelman driveway was overtopped by flow approx. 80 feet wide - head loss estimated to be about 1 foot. Vitale culvert reduced head - loss not measured or estimated. Vitale yard was partially flooded. Water was over banks on Ciliberti property. At NE 18th Street water was over bank and flooding on both sides of channel on upstream side of street. Head loss was not measureable with hand level - too small to observe difference - backwater from downstream apparently floods upstream side of street. Culvert at 247th Place NE apparently flowing without significant head loss - downstream channel flowing bank full. Culvert inlet at 244th Avenue NE & NE 22nd Street inudated to near bottom of top band of bird cage.

Date	Task Description
11/15/10	Telephone conversation with Joe Bookter - Mr. Bookter answered regarding timing that Ciliberti culverts were removed this last summer (2010), not certain regarding time or extent of channel cleaning - culverts on the Ciliberti property had been a regular location of beaver activity - He said that his friend Jeff Dodd's father excavated the outlet channel, that the channel was dug shallow in places because the father encountered hard pan, and that the Dodd's homesteaded the area in 1911 - Mr. Bookter moved to the neighborhood in the early nineteen-eighties and rode horses with Jeff Dodd extensively - Mr. Bookter also described an event during the construction of houses in the Beaverdam II plat - he said that water in ponds there had overtopped their berms and that a channel had been dug from the ponds into the adjacent power line easement - Mr. Bookter described that the flow went down to Northeast 8th Street and accross, and then the flow went eastward, across Northeast 8th again and continued in that direction - he said that inspectors put a stop to drainage into the power line easement.
1/6/11	Telephone conversation with Jed Irish - City of Sammamish obtained a permit to remove a beaver dam for construction of 244th Avenue NE extension bridge - a resident near ditch west of 244th Avenue NE claimed to have trapped ten beavers at about time of extension project start (2008?) - ditch channel enters Allen Lake in dense brush, an established site of beaver dam repairs - repairs have not occured since construction of bridge.
1/10/11	Telephone conversation with Joe Bookter - There are or have been fish in Allen Lake - in digging channel 60 or 70 years ago, Mr. Dodd & Bill Swen ran into hard pan on what is now parcel 2625069051 - Mr. Bookter said that Fish and Wildlife authorized dredging at this location during the fish window in the late 1990's or early 2000's before the Lucarellis lived there or their house was built - he said that the hard pan prevented work then also - firs that are dead around Allen Lake had been alive when he move there.

Appendix H **Notices on Title**

Table 3. Notices on Title within 500 feet of stream reach - NE 8th St. to 244th Ave. NE.

Parcel	Date	Specialist	Recording Number	Flood Hazard	Stream Type	Wetland Category	Permit Number
1311030060		Bottheim		✓		2	B96R2148
2625069005	11/22/1996	Bottheim		✓		2	B96R2146
2625069009	8/26/1994	Gillen	199409060498			3	B94A1320
2625069010	10/19/2004	Rose	20041026001165	✓	2S	2	B04M1710
2625069014	1/23/1997	Casey	199703170565	✓		2	B96R2148
2625069020	11/22/1996	Bottheim	199703170564	✓		2	B96R2147
2625069029	2/19/2002	Macwhinney	20020308000810		2S		B02L0027
2625069049	12/2/1993	Casey			2P		B93A6435
2625069051	11/16/2004	Rose	20041229001702	✓	2S		B04L1799
2625069059	11/15/1993	Casey	199312080787		2P		B93R2460
2625069066	2/23/1999	Klein	199903290524		3		B98Q0557
2625069066	1/22/1999	Klein			2P	2	B98A3180
2625069069			20051110001930				B05M0921
2625069091			20050629002457		2S		B04M1936
3525069028	8/18/2000	Casey	20001011001451		2S	1	L99CG426
8155850210	8/15/1997	Hurley	199710100898			3	B97R1356

Appendix I **Hydrologic and Hydraulic Calculations**

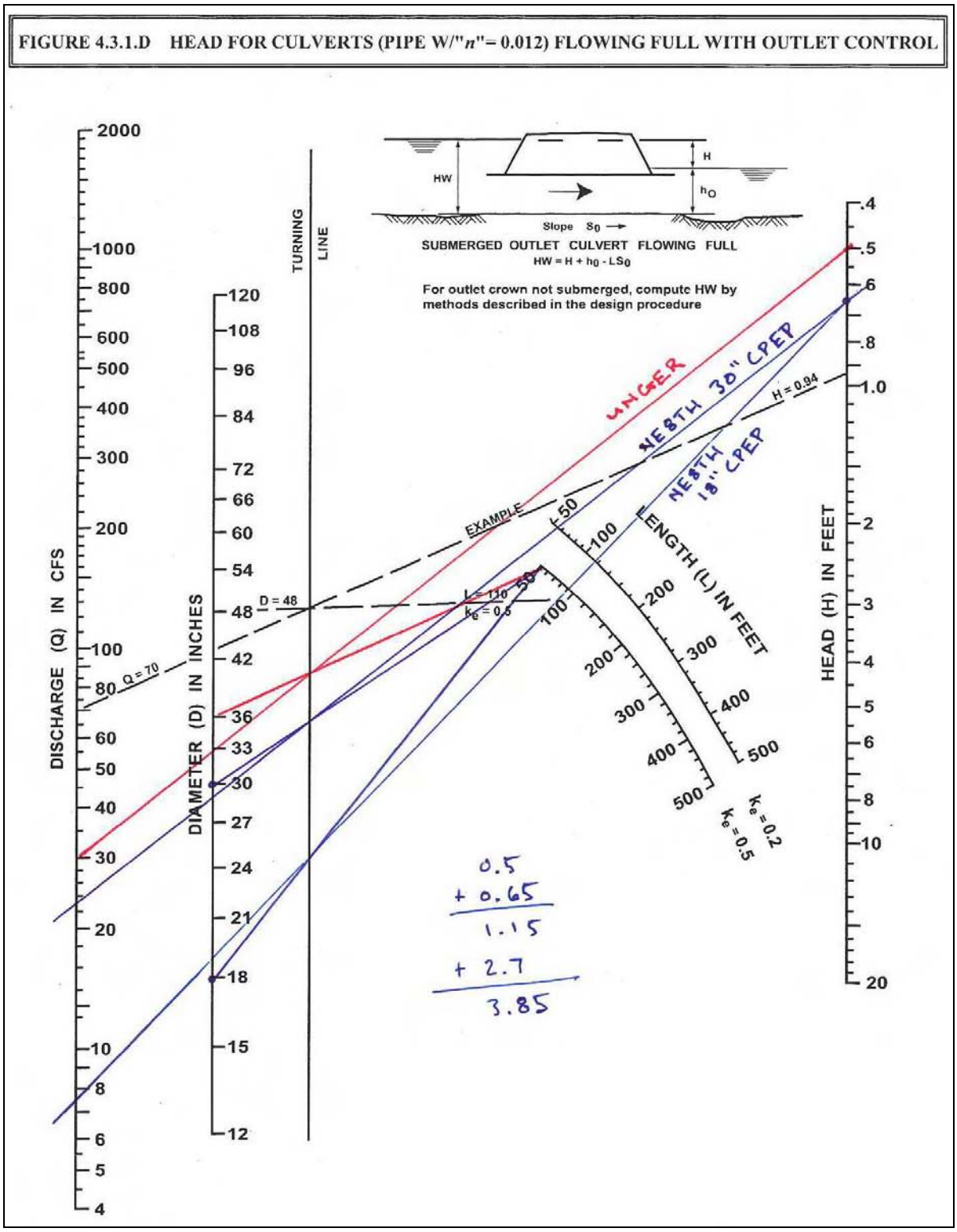


Figure 20. Nomograph for outlet controlled culverts - NE 8th Street & parcel 2625069054.

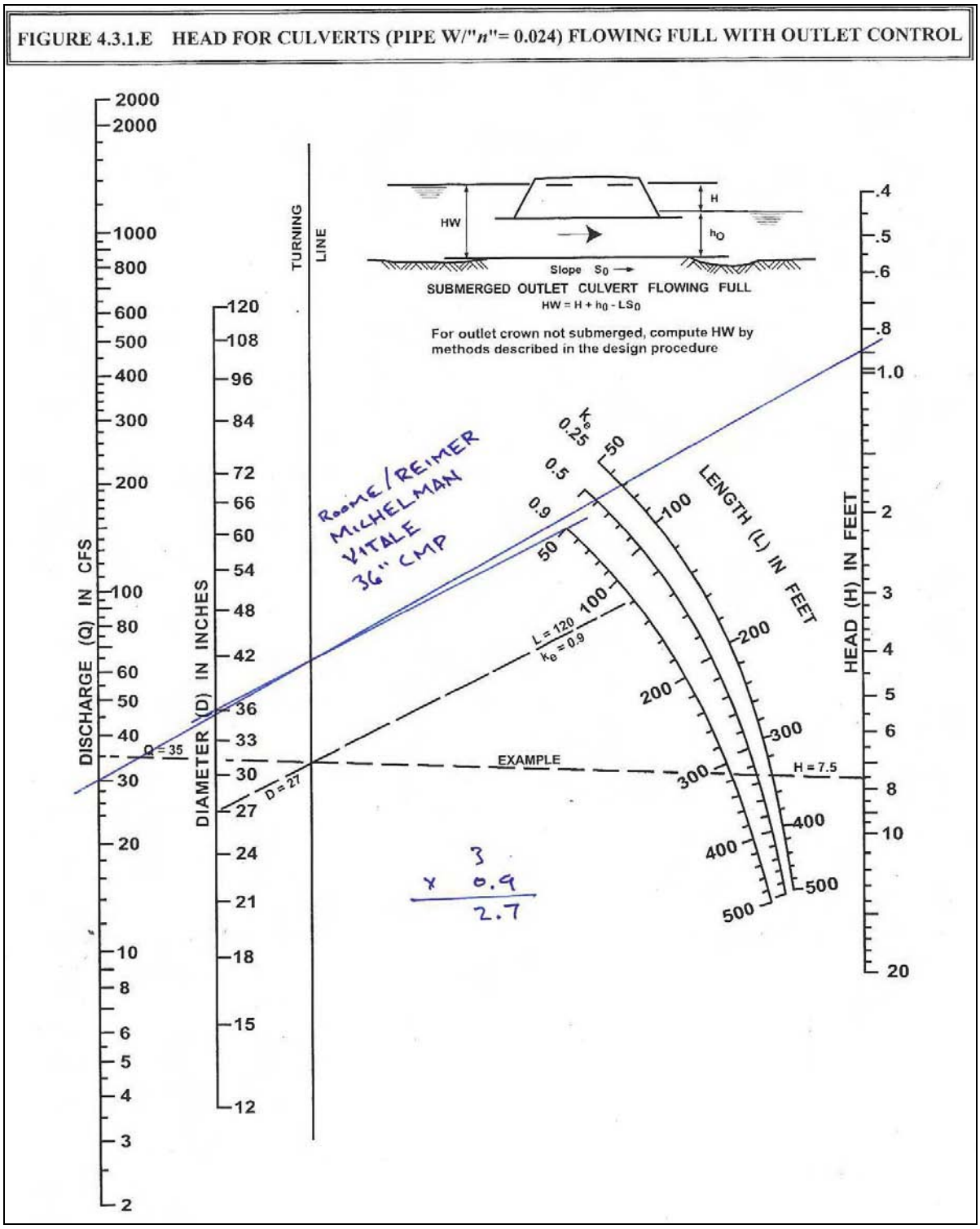


Figure 21. Nomograph for outlet controlled culverts - Roome/Reimer, Michelman & Vitale driveways.

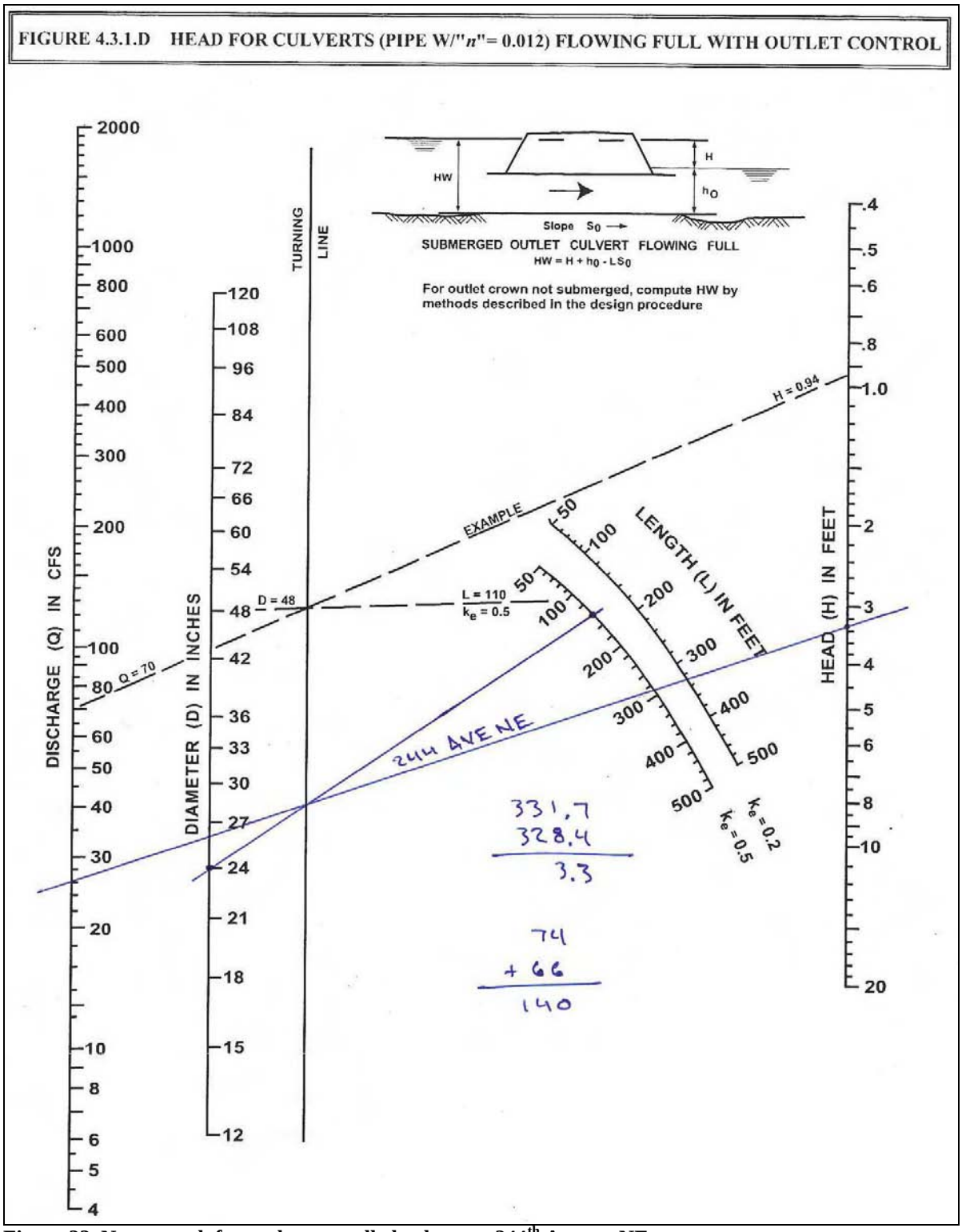


Figure 22. Nomograph for outlet controlled culvert at 244th Avenue NE.