PL 84-99 Green River Levee Rehabilitation

Project: FY 15 PN448194 Dykstra Levee Repair

Auburn, WA

95% DESIGN DOCUMENTATION REPORT

20 MAR 2015

Prepared by: PDT

Seattle District

US Army Corps of Engineers

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1. GENERAL

1.1 Background

The Dykstra Levee is located in City of Auburn, King County, Washington and is approximately 5,700 feet long from river mile (RM) 30.6 to 29.7. The levee is one segment of a three segment levee system. The Levee is a non-federal flood control project and the project is active in the Public Law 84-99 Rehabilitation and Inspection Program. See Figure 1 below for the approximate site locations.

Figure 1. Approximate site location (Auburn, WA)

During a flood event on March 10th, 2014 the Dykstra Levee was damaged at approximate river miles 30.5, 30.2, and 29.8. Damage was reported following a recent 2 yr event of 9,090 cfs at USGS gage 12113000, Green River near Auburn. This event is estimated to be a 2-yr return period, or about a 0.5 chance of exceedance for a given year. After the event, King County, the non-federal sponsor of the project, requested a repair with the Corps of Engineers and it was accepted by the Seattle District Corps of Engineers. A Project Information Report (PIR) was then completed and approved, accepting the project as a PL84-99 Levee Rehabilitation Project.

Three sections of the Levee were damaged and currently provide a 1 yr level of protection. The length of damage is 841 feet, Site 1 is 113 LF, Site 2 is 460 LF, and Site 3 is 268 LF. At site 1 one there is scour at the toe which has caused sloughing and a 2 foot vertical crack of the riverward levee slope to begin sloughing off. Sites 2 and 3 have sections of scour at the toe and embankments which left a 2-3 foot vertical face above the waterline.

This project will be awarded through Contracting using the Horizontal MATOC and will be managed through Construction Division.

1.2 Development of Design Alternatives and Selection

Because this site was confined in an urban environment, the design had to account for the following constraints:

- Provide adequate scour protection and layback slopes to a stable condition in order to reestablish the pre-damaged level of protection
- Maintain original levee toe location, avoid constructing beyond original footprint.
- Minimize footprint due to the confined real estate in the area

The selected least cost alternative was to Repair to Pre-Flood Level of Protection. The repair includes rebuilding 841 LF of the existing levee toe and slope. Riverward side slope work would include a layback of the slope to 2H:1V, a 15 foot crown, and a toe armored with rock. The repair will retain the pre-flood level of protection and restore armor to protect the structure from river flow. Slope protection will be achieved by riprap with a mean particle size of 16 inches with a toe entrenched to a potential estimated scour depth of 7 ft. Laying back the slope to 2H:1V will provide reliable flood protection by creating a more stable armored slope. Repair will restore the pre-flood 100 yr level of protection.

2. HYDROLOGIC AND HYDRAULIC (H&H) ANALYSIS USED FOR DESIGN

2.1 Hydrology

Dykstra levee is on the left bank of the Green River less than 1 mile downstream of the USGS gage #12113000, Green River near Auburn, WA. The Green River is regulated by Howard Hanson Dam, which is operated to prevent downstream flows at Auburn from exceeding 12,000 cubic feet per second (cfs) at the USGS gage. Several high flow events exceeding flood stage occurred over the last few years: 11,100 cfs (2009), 10,400 cfs (2011) and 10,100 (2012) and are shown in the figure below. Recent damages were observed subsequent to a daily maximum discharge of 9,090 cfs on March 10, 2014 reported at the gage. Accounting for the drainage area of Green River between the gage and the levee, the approximate discharge at the levee was 10,000 cfs (a 0.5 ACE event). These events are estimated to be approximately a 0.5 to 0.1 ACE (2-yr to 10-yr) events, for a given year.

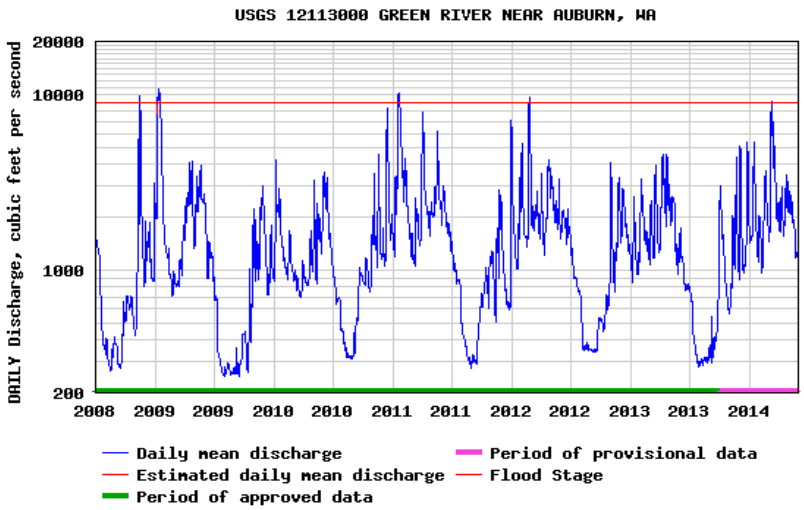


Figure 2: USGS Gage Peaks 2009-2014

2.2 Level of Protection

Review of hydraulic model suggest that the levee would be overtopped by a flood event associated with a 0.005 ACE (200-yr) event based on HEC-RAS model flood profiles. This is roughly consistent with the flood protection provided by Howard Hanson Dam to the Green River system. The loss of scour protection in three areas has compromised the pre-flood level of protection offered by the Dykstra levee. Flows contacting the damaged sections could erode the remaining armoring and exposed soil. Protective armoring along the damaged areas of the toe is missing and areas of the levee are sloughing. Therefore, the estimated level of protection provided by the Dykstra levee in its current condition is from a flood event with a 0.5 ACE (2-yr) event and corresponds to the point where damages would occur with some certainty if the levee provided no flood mitigation. The remainder of the levee and toe is assumed to be intact as no damage was reported.

2.3 Hydraulic Model

A HEC-RAS model was developed for this area of the Green River following the November 2006 flood event. The model was updated for use in the 2012 screening of this levee for the Levee Screening Tool (LST), which was used to inform this repair. Water surface elevations at cross-sections from this model through the area were used to determine the flood profiles at the damaged location, and velocity was used to inform riprap design.

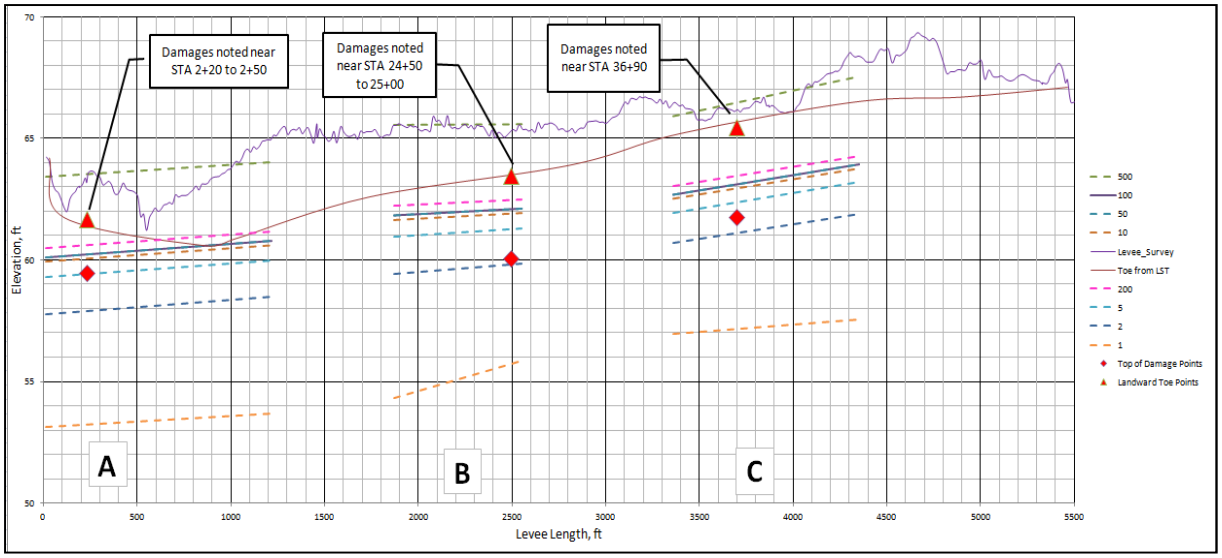
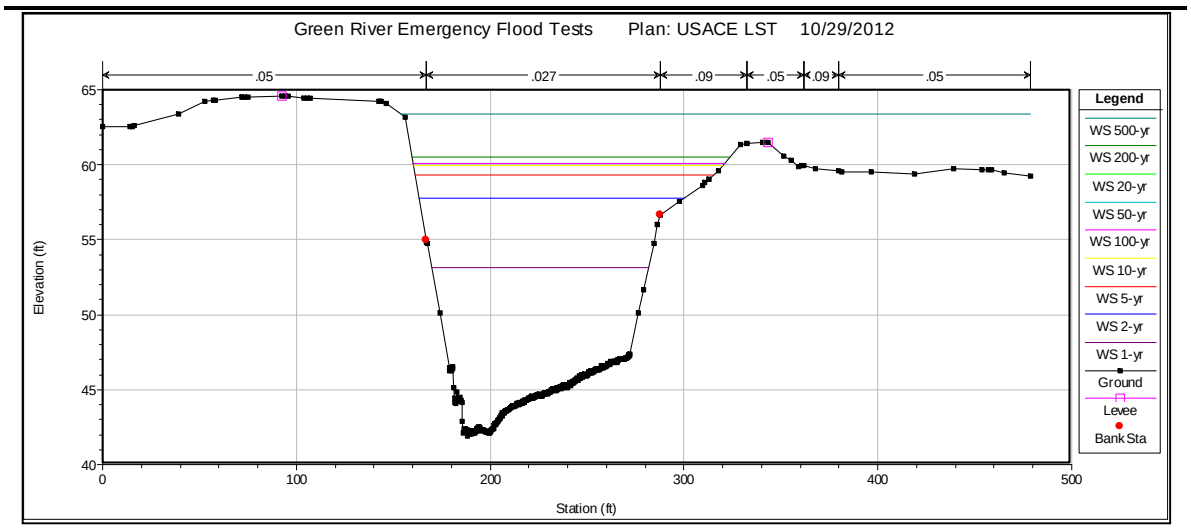


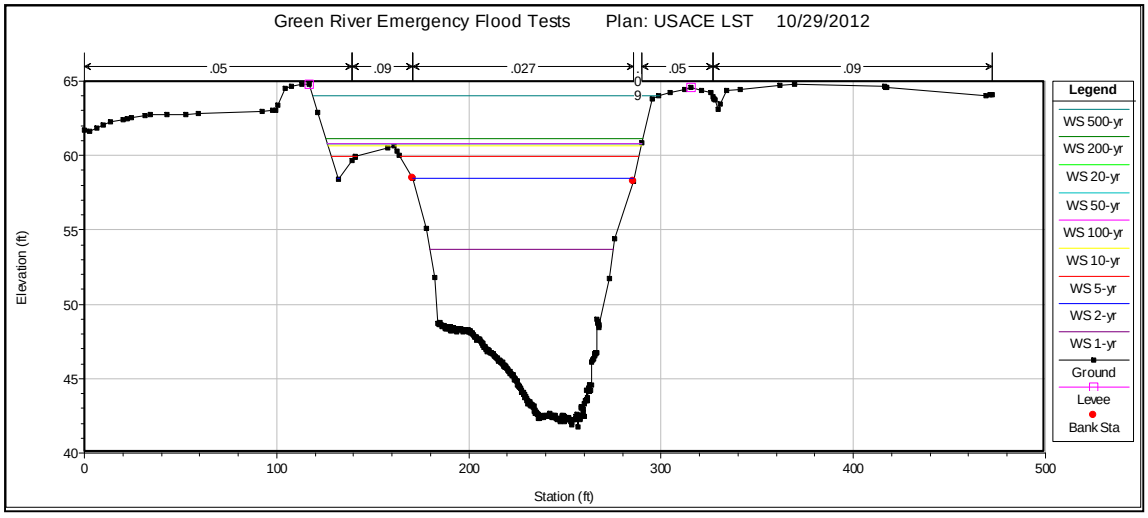
Figure 3. Dykstra Levee Flood Profiles (from HEC-RAS 2012); note that A is site 1, B is site 2, C is site 3

The locations of each damaged area are described below in reference to river mile (RM):

- Site 1: RM 29.715 to RM 29.939 (approximately 204 ft upstream of RM 29.715). Damages to slope noted 4 ft below crest.



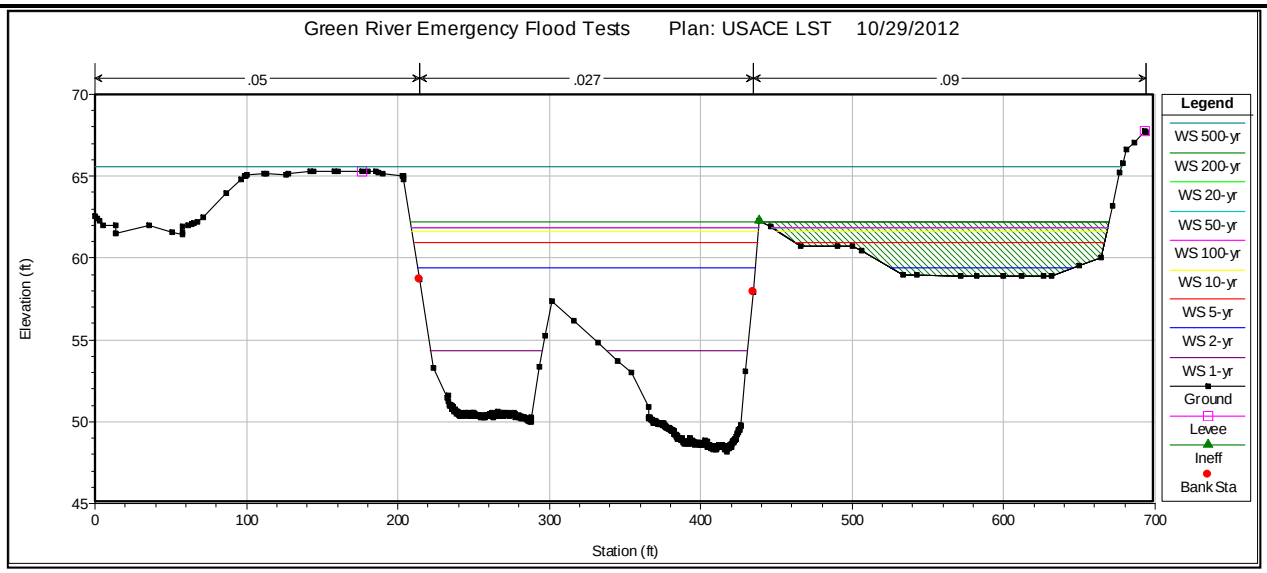
a. RM 29.715, Levee STA 15+20



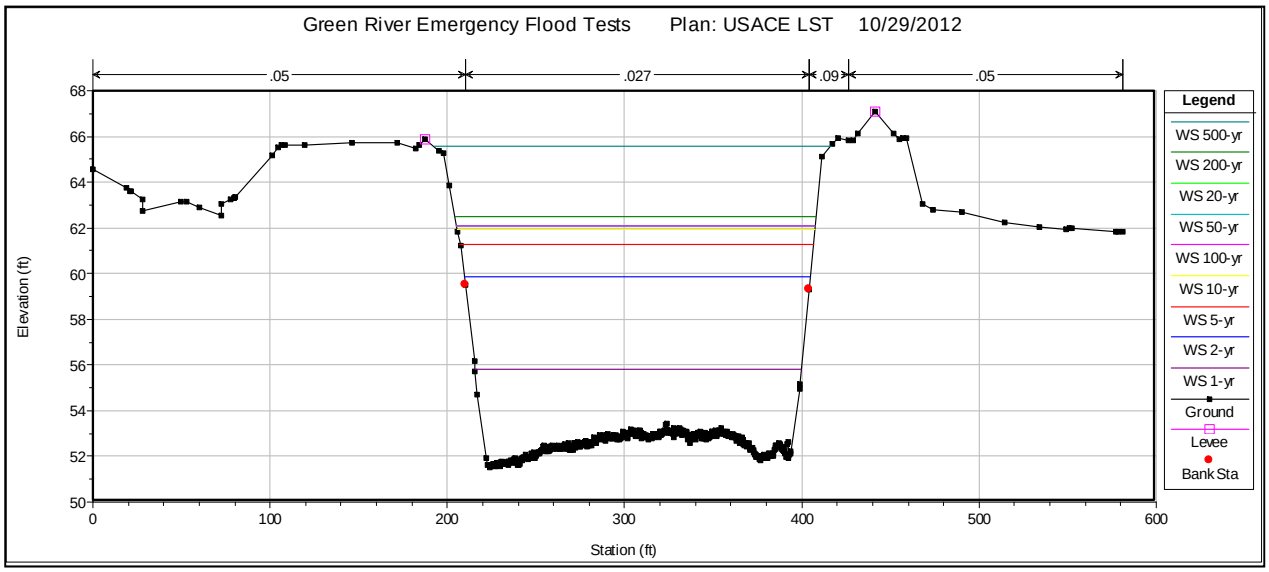
b. RM 29.939, Levee STA 12+16

Figure 4. HEC-RAS cross-sections near site 1

- Site 2: RM 30.080 to RM 30.210 (approximately 75 ft downstream of RM 30.210). Damages to slope noted 5 ft below crest.



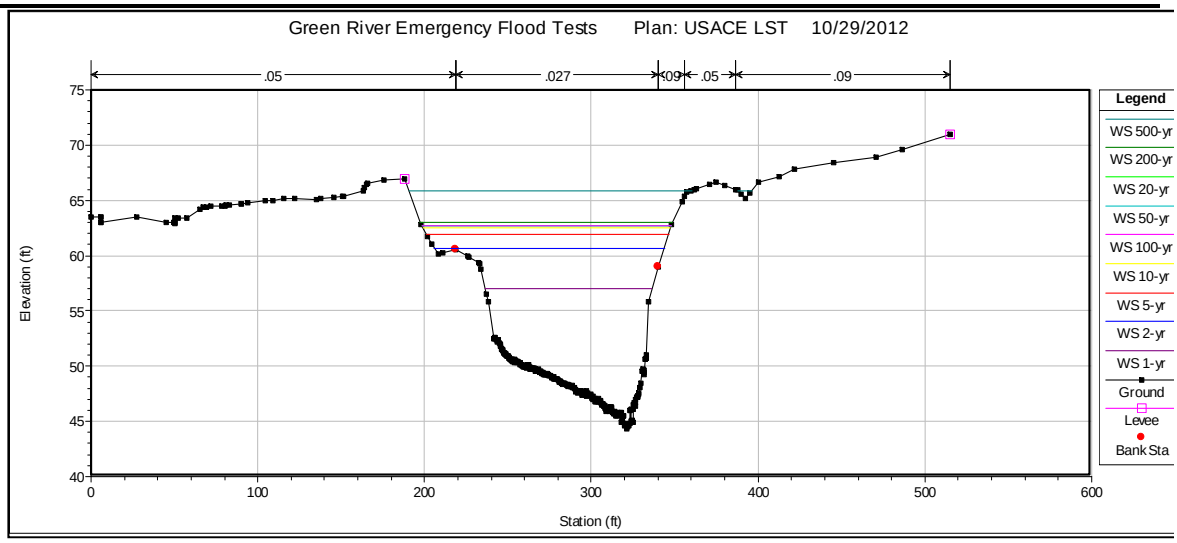
a. RM 30.080, Levee STA 18+71



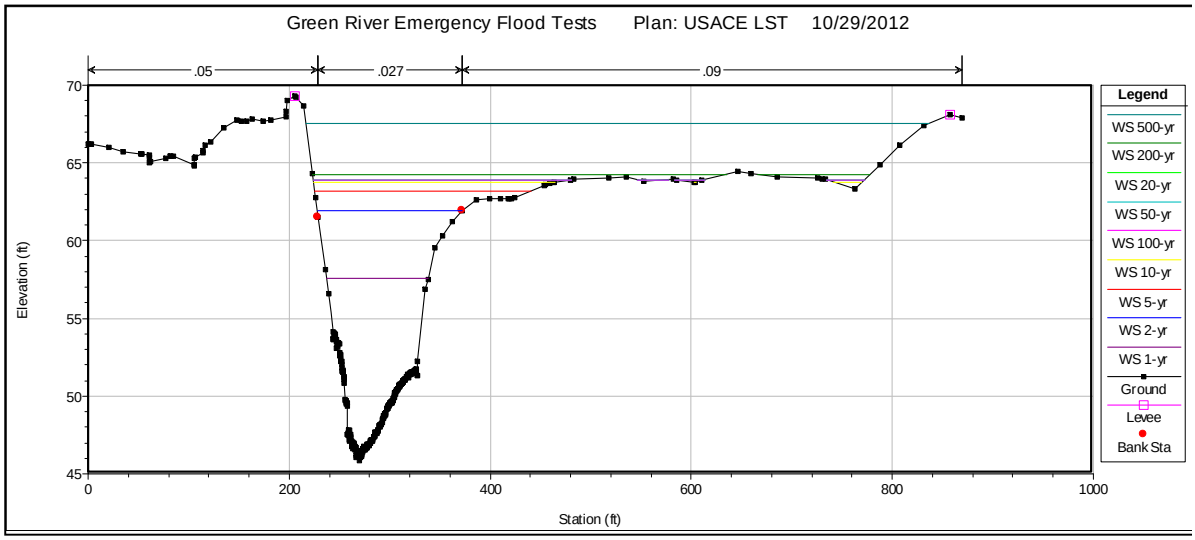
b. RM 30.210, Levee STA 25+52

Figure 5. HEC-RAS cross-sections near site 2

- Site 3: RM 30.377 to RM 30.588 (approximately 300 ft upstream of RM 30.377). Damages to slope noted 4 feet below crest.



a. RM 30.377, Levee STA 33+60



b. RM 30.588, Levee STA 43+51

Figure 6. HEC-RAS cross-section near site 3

2.4 Riprap sizing

Hydraulic model results were used in determining the appropriate riprap size classification using the program SAMwin, version 1.0. The program follows the procedure in EM 1110-2-1601 (USACE, 1994)

for cases where velocity and depth are given. Data used in this analysis came from the available detailed HEC RAS modeling, and the large wood load in this river is relatively minor with a minimal risk of impact from large wood. The minimum recommended 1.1 safety factor was found to be appropriate, and a thickness coefficient of 1.0 to determine the minimum thickness. In the case of Desimone levee, a D_{50} size of 18 inches was calculated (class 3). The top elevation of the riprap blanket should extend to at least 32 ft NAVD88, which is the 0.005 ACE (200 yr) water surface through the damaged area. The D_{max}, D_{30} and D_{50} size riprap are shown in the table below for each damaged area on Dykstra levee. Site 3 is exposed to the most severe conditions and is recommended for use as the representative section. Under this assumption, a minimum of Class III riprap should be placed. Blanket thickness should be the larger of d_{max} or 1.5 d_{50} (EM 1601).

Table 1. Riprap Sizes for each damage site

Damaged Site	D_{max}, inches	D_{30}, inches	D_{50}, inches
1	12	6	7
2	24	12	14
3	24	12	14

GENERAL GUIDANCE
FOR
RIP RAP GRADATION
(PACIFIC NORTHWEST RIVERS)
COE

Class	I	II	III	IV	V
Rip Rap Thickness	18"	24"	30"	36"	48"
100% Smaller than	150# (12")	500# (18")	800# (20")	1000# (22")	1800# (27")
50% Size	50# (8")	200# (13")	300# (15")	400# (16")	750# (20")
90% Larger than	25# (6")	100# (10")	150# (12")	200# (13")	350# (16")
10%	25# (6")	25-100# (6"-10")	25-150# (6"-12")	25-200# (6"-13")	25-350# (6"-16")
Tolerance	+4"	+6"	+8"	+12"	+16"
Velocity fps	6-10	10-14	14-16	17	18

1. Assuming w = 165 lb/ft^3
2. Assumes 1:2 slope; for slopes up to 1:1½, use same class with double the thickness.
3. Assumes that the L/W ratio of the rock is no greater than 3.
4. Riprap gradation for use on the outside bank of a bend should be based on a selection velocity that is twice the average channel velocity.
5. Riprap gradation for use on the banks of a relatively straight reach should be based on a selection velocity that is 1.5 times the average channel velocity.
6. Riprap gradation for channel bottoms should be based on the average channel velocity.
7. INCH (") SIZE IS MINIMUM DIMENSION

Example Class II

90% of stones shall range between 100 and 500 pounds. The 50% size of the gradation shall be 200 pounds. 10% of the stones may range between 25 and 100 pounds.

Figure 7. General Guidance for Riprap Gradation for Pacific Northwest Rivers

2.5 Toe Scour Estimates

Scour depths for each damaged area were calculated comparing the maximum depth from several applicable relationships given in EM 1110-2-1601 and the National Engineering Handbook. A summary table of maximum scour depths and applicable methods at each damaged area on the Dykstra levee is provided below. Site 1 is on the outside entrance to a bend, site 2 is in relatively straight section and site 3 is on the inside entrance to a bend. It is recommended that the buried toe be re-established back to the pre-flood condition. Volumes should be bulked by a minimum of 50 percent to account for launching distance less than 15 ft if a launching toe is used. It is not anticipated that placement of toe rock will produce a rise in the 0.01 ACE (100-yr) water surface.

Table 2. Maximum Scour Depths at each Damaged site

Damaged Site	Depth, ft	Method
1	4.0	Laursen Live bed – contraction scour
2	7.0	Laursen live bed – contraction scour
3	6.0	Bend scour, EM 1601

Recommended stone volume can be calculated for launch distance less than 15 ft as: volume per unit levee length= 3.35 x blanket thickness x scour depth (EM 1601):

Site 1: volume= 3.35 x 2 ft x 4 ft = 27 sq ft/ ft of levee length

Site 2: volume= 3.35 x 2 ft x 7 ft = 47 sq ft/ ft of levee lengthSite

3: volume= 3.35 x 2 ft x 6 ft = 40 sq ft/ ft of levee length

2.6 Recommended Repair Alignment

The repairs were designed to be sufficiently long that the transition to the existing rock is not subject to excessive stress such as what would occur at bends, contractions, etc. Typically for bends this involves extending the rip rap blanket at least 1 channel top width upstream from the point of curvature and at least 1 to 2 channel top widths downstream from the point of tangency (USACE, 1994). This is to prevent flanking of the repair. If rip rap is terminated in an erosive area within the bend, the blanket ends can be thickened and keyed in to prevent unraveling.

Site 3 is on the left inside bank on the approach to a bend and experiences a slight flow contraction. The recommended repair was extended one channel top width upstream of the point of curvature going into the bend and just downstream of the transition into the bend.

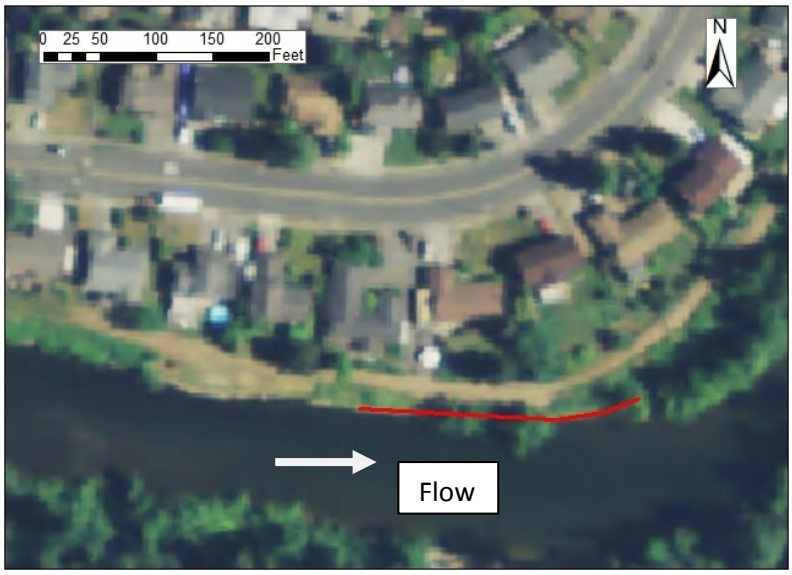


Figure 8. Site 3

Site 2 is just downstream of a flow split around an island. The recommended repair was extended upstream just past the flow contraction, and downstream to intersect an adjacent repair section.

Figure 9. Site 2

Site 1 is located on the left outside bank entering a bend. The recommended repair was extended one channel top width upstream of the point of curvature going into the bend, and downstream to an existing culvert gate.

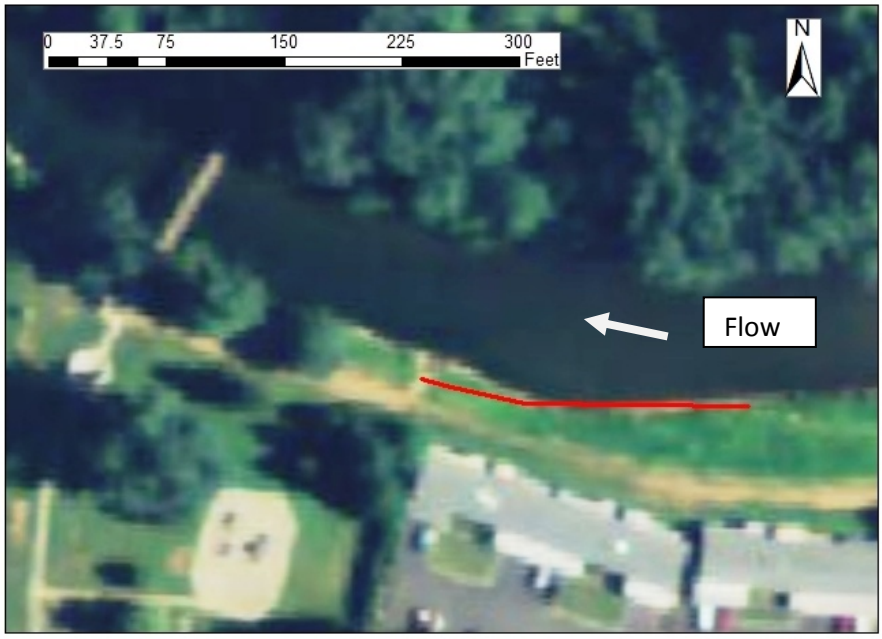


Figure 10. Site 1

3. GEOTECHNICAL ANALYSIS USED FOR DESIGN

3.1 Geotechnical Investigation:

Borings or other excavations into the project area as part of a geotechnical investigation were not performed specifically for this project. This project will be in an area close to where previous repairs have been performed, so the levee embankment composition is generally known. The overlying slope material is assumed to be silt deposited over time by the river. Levee fill material comprises the levee embankment and is assumed to be silty sandy gravel to gravelly silty sand.

3.2 Recommended Design:

It is recommended that existing fill be reworked, setback, and placed along the embankment to establish a 2H:1V maximum slope and that a riprap blanket with a armored toe be installed on the placed fill, to the grades indicated in the plans . The 3 foot blanket of class III riprap will overlay a 1 foot layer of 4" x 8" quarry spalls. The fill gradation is shown in Table 5. This material was checked against USACE filter criteria (EM 1110-2-1901) for use in filtering the native base material and to filter against material loss due to erosion and wave action. Top soil will be added above the riprap to provide for native plantings and seeding above OHW.

The requirements for riprap are shown in Section 2 of this document. The result that requires the most riprap will be used for all three sites. Riprap design based on the flow and channel geometry gives a minimum riprap thickness of 36 inches with an additional 47 ft^3/ft (11.11 yd^3/ft of launchable toe to protect against scour. The required riprap gradation is as follows in Table 3, and other material gradations for the project are shown in Table 4, 5, 6, and 7:

Table 3. Class III riprap – Assumed Specific Gravity = 2.65

Distribution	Weight (lb)	Diameter (in)
100% Smaller	800	22-30
50% Size	300	16-22
90% Larger	150	12-16
10% Range	25-150	7-13

Table 4. 4”x8” Quarry Spall Rock (All percentages are by weight.)

Sieve Size	Percent Passing
8”	100
4”	0

Table 5. Embankment Fill (All percentages are by weight)

Sieve Size	Percent Passing
3”	100
2”	90 – 100
1”	70 – 90
½”	55 – 85
No. 4	35 – 75
No. 40	15 – 50
No. 200	10 – 15

The topsoil for the project will consist of a 75/25 mixture of engineered soil and organic compost, respectively. The engineered soil will meet the following gradation, and shall be free of roots, chemicals, garbage, and debris.

Table 6. Engineered Topsoil (All percentages are by weight.)

Sieve Size	Percent Passing
½”	100
#4	75-100
#10	40-75
#16	25-55
#40	25-50
#200	10-20

Table 7. 1.25” Crushed Surface Base Course (All percentages are by weight.)

Sieve Size	Percent Passing
1¼”	100
1”	80-100
⅝”	50-80

No. 4	25-45
No. 40	3-18
No. 200	7.5 max.

3.3 Stability Analysis:

A stability analysis was performed on the recommended design discussed above using the materials described above and GeoStudios software. Two scenarios were analyzed for stability. The first was static water conditions at the ordinary high water level, and the second was a rapid drawdown situation where flood water reaches near the top of the levee and then is rapidly lowered to ordinary high water level. In both instances the factor of safety was at or above 1.5 and had a very small slip surface. The sections have been determined to be stable. See Appendix B for the results.

4. CIVIL ANALYSIS USED FOR DESIGN

4.1 Site Access and Staging Area

Access for Site 1 is through the City of Auburn Dykstra Park on 22nd st NE. A construction access and access road will need to be constructed to get from the street through the park to the repair site. The Staging area for Site 1 is in Dykstra Park between the access road and the apartment complex fence. No trees should be cut down for the staging or access, the intent is that the access can shift to avoid the trees with some minor tree trimming.

Access for Site 2 is through an existing King County Levee Access point at the corner of 22nd St NE and River View Dr NE. From the access point the repair starts a few hundred feet upstream and will be accessed along the levee top. The King County Levee Access point is large enough that it will act as the staging area as well.

Access and the staging area for Site 3 are through a parcel of land that is owned by King County on River View Dr NE. The parcel provides direct access to the upstream end of site 3. The lot is currently an empty grass parcel except for a chain link fence. A construction access will need to be constructed through the parcel to the levee alignment.

See Appendix C for design drawings with staging and access locations.

4.2 Layout

The total project length is 841 LF including all three damaged sites. All three sites will use a similar cross section. Starting from the pre-flood toe location the section will come up at a 2H:1V slope to the shoulder of the levee crown and then a 15’ levee top. Due to the over steepened nature of the existing levee slope, in most locations the crown of the levee will be set back from the existing centerline. See the drawing package for detailed view of the cross sections.

At site 1 the repair is 113 LF long and the landward side of the levee is directly adjacent to an apartment complex. For this site there is one typical section, the intent of the repair is that the contractor should start by matching the downstream existing section and transition smoothly over the length of the project to match the upstream existing section. At the upstream end, construction of the levee section will require the excavation of the silt bench. Upon completion of the levee section the intent is to have the silt bench built back up over the new levee prism.

At site 2 the repair length is 460 LF long and the landward side of the levee is adjacent to fenced backyards. The project will encroach approximately 5-10 LF into these back yards and will require the fences to be removed and replaced in kind at the toe of the new levee prism. The downstream end of the site will tie directly into the 2008 Dykstra repair with a 50 LF transition. The upstream end will have a 50 LF transition back to the existing levee prism.

At site 3 the repair length is 268 LF long and the landward side of the levee is adjacent to fenced backyards. This site should not encroach into the adjoining backyards. The downstream end of the repair will transition over 100 LF back to the existing levee prism. This will require that the silt bench in front of the levee prism be excavated and the intent is that the silt bench will be rebuilt once the levee section has been completed. The upstream end of the repair will transition over 75 LF back to the existing levee prism.

4.3 Utilities

Site 1 has a 42” Corrugated Metal Pipe Culvert with a concrete headwall and Tideflex gate at the downstream end of the repair. The headwall is currently undercut and missing armoring. The headwall undercut will be backfilled with quarry spalls to prevent further erosion and the new levee work will be graded to be flush with the existing headwall.

There are no known utility at sites 2 and 3.

4.4 Survey Information

Due to the compressed schedule and limited design budget we will not be getting a full survey of the project sites. We will be using poor quality topography and planimetrics data from Arial photographs taken for King County in 2006 at 1"=100' Scale. Because this data does not include any bathymetry to show us the toe location of the existing levee, the King County Data will be supplemented with several cross sections taken by the PDT to estimate the toe location. This supplemental data is a very rough estimate of the toe location and is only one or two point along each repair site (anywhere from 100' to 460'). The supplemental data will only be used in the design effort and will not be displayed in the drawing package.

This is a very normal way that we do PL-84-99 Levee Rehabs but because this one will be awarded to a contractor using a MATOC there will be some risk involved with this path forward. The risk being that the contractor comes back with a Modification for a change in site conditions. Examples of this could be a scour hole that we did not see, an overestimation of the horizontal toe location, or an

underestimation of depth to the toe of the levee. We will do what we can to minimize these risks and incorporate some flexibility in contract for excess material handling.

4.5 Material Quantities and Calculations

Material quantities were based on end areas of the typical sections imposed on the existing cross sections cut using Inroads. Quantities are summarized in Table 6, below. See Appendix C for bulking factors added to quantities.

Table 6. Material quantities

Site Length (ft)	Topsoil (cy)	Quarry Spalls (cy)	Crushed Gravel (cy)	Class III Riprap (cy)	Fill (cy)	Cut (cy)
Site 1- 113’	63	234	20	650	0	1250
Site 2- 460’	258	752	85	2340	0	4760
Site 3- 268’	150	463	50	1530	0	2920

Detailed calculations for the quantities can be reviewed in **Appendix C**

5. ENVIRONMENTAL COMPLIANCE

5.1 Best Management Practices and Conservation Measures

The proposed repair includes rebuilding a total of 850 LF of levee embankment and toe at three non-contiguous sites. The repair will establish the levee to the pre-flood level of protection by regrading the slope to 2H:1V and adding replacement armoring to protect the structure from scour. Pre-flood slopes vary between 1.5:1 and 2:1, and bank micro-topography changes make the length of slopes being laid back impossible to quantify. Therefore, any portions of the slope being laid back from 1.5:1 to 2:1 will not be claimed as part of the project mitigation. The armoring consists of a 3-foot blanket of Class 3 riprap over a 1-foot blanket of quarry spalls. Rock sizing is consistent with 2008 repairs to the levee. Site 1 has a 42-inch metal culvert with Tideflex duckbill gate and a concrete headwall. The culvert is not damaged, but the downstream transition at Site 1 ends at the headwall. In order to ensure no loss of stability to the headwall, armoring will be replaced upstream, downstream and below the headwall as stabilization. No repairs will be needed to the culvert or headwall. Two rows of willow lifts will be incorporated into the design as well as a 1-foot blanket of topsoil on the upper slope of the embankment. See the typical cross section in Figure 3. The proposed toe and embankment work would include in-water excavation and riprap placement. The work area at all three sites will be isolated from the river with supersacks (approximately 1-ton sand bags), silt curtain, or a similar method.

Site 1 is near Dykstra Park and is a riprap bank covered with a grass lined slope. At the toe of the slope exposed armor rock is visible. The levee in this location contains a large four-foot outfall at the downstream end. Site 2 is predominantly herbaceous invasives including blackberry (*Rubus armeniacus*) and reed canarygrass (*Phalaris arundinacea*) with few rose and snowberry. Two mature Douglas-fir trees (approximately 18 to 20 inch diameter at breast height [DBH]), a willow thicket and several smaller trees of various species may be removed for the proposed construction. Site 3 is largely covered by blackberries; however eight alders (approximately 6 to 14 inch DBH) and one willow thicket may be removed for the proposed construction.

Two willow lifts will be installed into the riverward face of the levee. The willows will be placed at or just above ordinary high water. The lift is installed by placing four inches of soil along the bottom of the excavated area, extending from the levee embankment material to the riverward face. Live willow cuttings, approximately three feet in length, are then placed perpendicular to the levee face every 12 inches. The willows are then covered by four more inches of soil. Levee armor is then placed onto the willow lift to create the armored upper slope. Willow cuttings will be purchased from a local nursery to ensure that Hooker's willows (*Salix hookeriana*) or Sitka willows (*S. sitchensis*) are used. These willow species stay relatively small and bushy, with flexible stems. Pacific willows (S. lasiandra) will be placed into the lifts, one stem every 20 feet (for a total of 85 plants). Pacific willows are fast-growing, tall tree with a height of 40 feet at maturity (King County 2013). Also, at the top of the bank, after construction is completed, a layer of topsoil will be placed onto the compacted levee fill. This topsoil will be seeded with a native seed mix.

Several measures would be employed during construction to minimize adverse project effects on protected species and their habitat. Each project must adequately comply with these impact reduction measures to ensure a "not likely to adversely affect" determination:

- The work area at all three sites will be isolated from the river with supersacks (approximately 1-ton sand bags), silt curtain, or a similar method.
- Construction will occur when Chinook, steelhead and bull trout are least likely to be present in the action area. The work window for this reach of the Green River is 1-31 August.
- Work area is restricted to areas of existing and functional flood control structures.
- Vegetation removal is limited to the repair sites.
- No net loss of wetlands or sensitive aquatic sites.
- Willows will be planted at/near ordinary high water along the full length of the repair sections.

Construction best management practices (BMPs) as suggested by the Washington State Department of Ecology during previous rehabilitations and flood fights will be included during the construction. See Table 1.

Table 1. BMPs Implemented During Construction

1. Equipment used near the water will be cleaned prior to construction.
2. Work will be conducted during a period of low flow.
3. Rocks will be individually placed along the riverward slope and toe. No end dumping of rock will occur.
4. Biodegradable hydraulic fluids will be used in machinery where appropriate.
5. Refueling will occur on the backside of the levee.
6. Construction equipment shall be regularly checked for drips or leaks. Any leak would be fixed promptly or the equipment would be removed from the project site.
7. At least one fuel spill kit with absorbent pads will be onsite at all times, and personnel will be properly trained in its use.
8. Drive trains of equipment will not operate in the water.
9. At least one biologist will be onsite or available via phone during construction.
10. Periodic water quality monitoring will be conducted during construction.

In addition a Fueling and Spill Recovery Plan will be developed prior to construction that will include specific BMPs to prevent any spills and to prepare to react quickly should an incident occur. A Stormwater Pollution Prevention Plan will also be developed to identify potential sources and reduce pollutants in stormwater discharges from the construction site.

5.2 Environmental Laws and Statutes

The following table details the compliance including any specific requirements with all applicable laws and statutes.

Table 7. Status of Project with Applicable Laws and Statutes

Federal Statutes and Executive Orders (EO)	Compliance Status	Specific Requirements
National Environmental Policy Act of 1969, as amended	Not Complete	If the Environmental Assessment determines that no significant impacts would occur as a result of the proposed project a Finding of No Significant Impact would be signed by the District Engineer, signifying compliance with this law.
Clean Water Act of 1977, as amended	Not Complete	The project is functionally analogous to Nationwide Permit 3. Furthermore, the Corps analyzed the project pursuant to the conditions attached to NWP 3 and concludes that the project satisfies the conditions and qualifies for the State's pre-certification for Section 401 of the Clean Water Act and pre-determined consistency concurrence for the Coastal Zone Management Act. Water quality monitoring will occur during

		in-water construction to ensure State water quality standards are met. Section 402 of the Clean Water Act will be triggered by the Phase 2 construction. The area of ground disturbance is expected to be approximately 2 acres. A Storm Water Pollution Prevention Plan will be written and an application for a National Pollutant Discharge Elimination System Permit will be submitted to the EPA prior to construction. The State Department of Ecology concurred in a Letter of Verification (LOV) on [INSERT DATE]. Section 402 of the Clean Water Act will be triggered by the construction. The area of ground disturbance is expected to be approximately 1 acre. A SWPPP will be written and an application for a National Pollutant Discharge Elimination System Permit will be submitted to the EPA by the Contractor prior to construction.
Coastal Zone Management Act	Not Complete	The project is functionally analogous to Nationwide Permit 3. Furthermore, the Corps analyzed the project pursuant to the conditions attached to NWP 3 and concludes that the project satisfies the conditions and qualifies for the State's pre-determined consistency concurrence for the Coastal Zone Management Act. The State Department of Ecology concurred in a LOV on [INSERT DATE].
Endangered Species Act of 1973, as amended	Not Complete	A Biological Assessment was submitted to the National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service (USFWS) on25 February 2015. Based on implementing the BMPs and conservation measures, the Corps determined that the project **may affect but is not likely to adversely affect** Coastal Puget Sound DPS bull trout (*Salvelinus confluentus*) Puget Sound Chinook (*Oncorhynchus tshawytscha*) and Puget Sound steelhead (*Oncorhynchus mykiss*), and **may affect, but is not likely to adversely affect** their designated critical habitat. Additionally, the project is expected to have **no effect** to marbled murrelet (*Brachyramphus marmoratus*) or southern resident killer whale (*Orcinus orca*). The NMFS and USFWS concurred with this finding on [INSERT DATES] respectively.
Migratory Bird Treaty Act	Complete	Any disturbance caused by the proposed action to migratory birds would be minimal; minimal vegetation removal would occur, construction would be of short duration, and timing of the construction will avoid breeding season. Because no direct harm to any migratory birds is anticipated, a take permit under this act is not required.
National Historic Preservation Act of 1966, as amended	Not Complete	The Corps is currently taking actions to identify historic properties that may be affected by the proposed action as required by Section 106 of the National Historic Preservation Act. The Corps is consulting with the Washington State Historic Preservation Officer, Indian tribes, and other consulting parties, about the project and will complete identification and evaluation for historic properties as well as make agency findings of effect for Section 106 prior to approval of the proposed action. As of this time, the Corps has not identified any historic properties within the area of potential effect and

		does not anticipate that the proposed project would affect historic properties.
Clean Air Act	Complete	The proposed activity constitutes repair of an existing facility, generating an increase in direct emissions of a criteria pollutant or its precursors that is clearly *de minimis*, and is therefore exempted by 40 CFR Section 93.153(c)(2)(iv) from the conformity determination requirements. Emissions generated by the construction activity are expected to be minor, short-term, and well below the *de minimis* threshold.
Bald and Golden Eagle Protection Act	Complete	No take of either bald or golden eagles is likely during project construction. The closest bald eagle nest is approximately 235 feet away from Site 2 on the opposite bank of the Green River. Fledging occurs for most young eagles by mid-July in Washington, so the timing of construction during the in-water work window will likely avoid nesting eagles However, since nesting season extends through August, a non-purposeful take permit must be obtained from the USFWS. An application was submitted to the USFWS on 25 February 2015. If a nest or juveniles are observed during construction, appropriate measures would be taken to ensure no harassment occurs.
Floodplain Management Guidelines (E.O. 11988)	Complete	By Corps policy, the provisions of EO 11988 are not applicable to the repair of flood control works to the pre-existing level of flood protection, as the repair actions do not directly affect either the modification or occupancy of floodplains, and do not directly or indirectly impact floodplain development.
Protection of Wetlands (E.O. 11990)	Not Complete	A wetland survey will be conducted prior to finalization of the design to determine the presence of wetlands at Site 1.
Environmental Justice (E.O. 12898)	Complete	Since no adverse human health or environmental effects are anticipated to result from the project, the Corps has determined that no disproportional adverse impacts to low-income or minority populations would occur.

6. TECHNICAL REVIEW

Two independent technical reviews have been conducted: the first (65% design) from 3/21/14 to 4/2 (including backcheck), and the second (95% design) anticipated from 6/24/14 through 11/21/14 (including backcheck). A biddability, constructability, operability, and environmental review (95% design) is being accomplished by having Emergency Management engaged during the design process and providing input. Results of all reviews will be included in the 100% DA. A construction monitoring plan will also be developed prior to completion of the design.

APPENDIX A. H&H Support Data

REFERENCES

Unpublished, Date Unknown. “General Guidance for Rip Rap Gradation (Pacific Northwest Rivers).” Provided to Tetra Tech from Emergency Management Branch, USACE.

US Army Corps of Engineers (USACE), 2010. HEC-RAS River Analysis System – User Manual. Technical Manual CPD-68.

US Army Corps of Engineers, 1994. “Engineering and Design - Hydraulic Design of Flood Control Channels”, EM-1110-2-1601, Department of the Army, Washington D.C.

Washington Department of Fish and Wildlife (WDFW 00046), 2003. Aquatic Habitat Guidelines Program, Integrated Streambank Protection Guidelines (ISPG).

National Engineering Handbook Technical Supplement 14B, Scour Calculation. August 2007.

CENWS-EN-HH-HE 14 February 2014

MEMORANDUM THRU
Hydrology and Hydraulics Branch (CENWS-EN-HH/Reese)
Geotechnical and Environmental Restoration Branch (CENWS-EN-GB/Shaw)

FOR Seattle District Levee Safety Officer

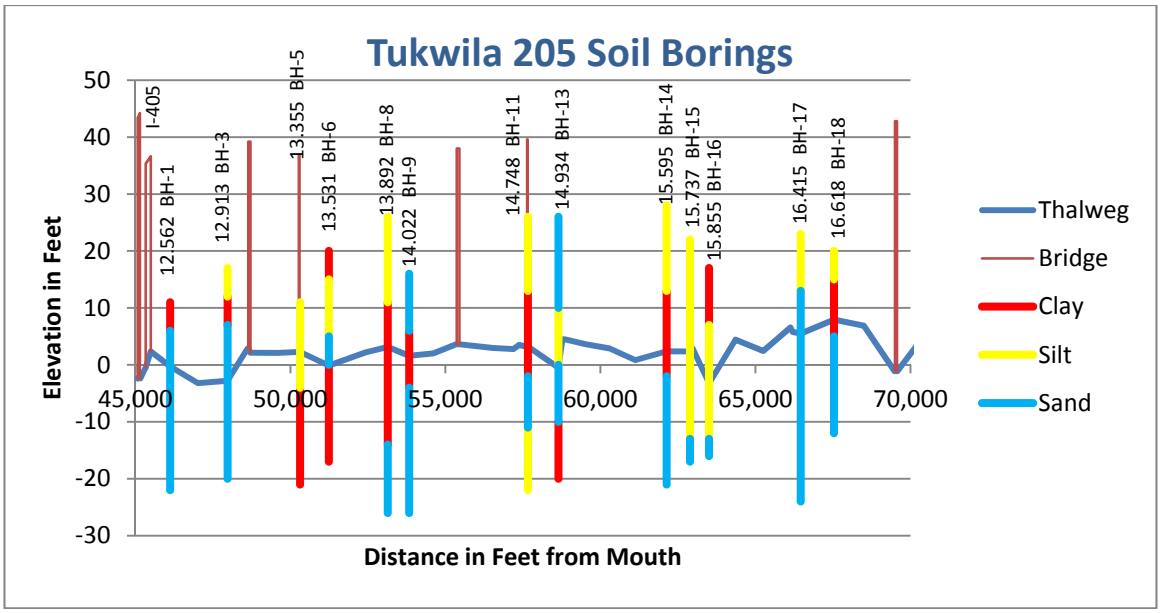
SUBJECT: Tukwila 205 Levee Toe Scour and Bank Stability

1. Hydraulic Engineering Section has raised concerns about the safety/reliability of the Tukwila 205 levee, since September 2007. Our concern is that the levee could fail during a 1 percent chance storm due to toe scour in the bends. This concern was triggered by levee damage caused by toe scour during the November 2006 flood event.

2. EC 1110-2-6067; USACE PROCESS FOR THE NATIONAL FLOOD INSURANCE PROGRAM (NFIP) LEVEE SYSTEM EVALUATION, issued 31 August 2010, contains specific guidance on the responsibility of USACE to re-evaluate a previously certified levee system.

3. In October 2010, a Work Request was issued by EN-HH-HE to EN-GB-SS to evaluate the scour induced slope instability of the Tukwila 205 levee. A draft slope stability report was prepared in February 2011 and transmitted to EN-HH-HE in October 2011. The results of the report indicate the factor of safety against slope instability drops below 1 if the vertical scour depth exceeds approximately 7-10 feet. For the maximum potential scour depths of between 17 and 46 feet, the factors of safety are approximately 0.8 and 0.43 respectively. For modeling simplicity the entire alluvium strata was assumed to be a silty sand of medium density in the stability analysis. This assumption was based on 14 available soil borings in the area.

4. Following the slope stability analysis, it was decided by EN-HH-HE and EN-GB-SS to conduct a geotechnical investigation of soil conditions at each of the bends. The geotechnical investigation was conducted from 9 to 18 September 2013 at seven bends on the Tukwila 205 levee. A Field Investigation Report was completed on 29 November 2013 by Omaha District. The figure below provides a simple presentation of the soil conditions and river thalweg. At five of the seven bends there is at least 10 feet of erodible silt or sand below the thalweg elevation. During a large storm, there is the potential for those five bends to scour to depths that would reduce their slope stability factors of safety to less than 1.



5. Based on the scour depth determinations from EN-HH-HE, the preliminary slope stability analyses and geotechnical investigation conducted by EN-GB-SS, it appears that the Tukwila 205 levee does not meet the design standards for toe protection given in EM 1110-2-160, Hydraulic Design of Flood Control Channels. While the NWS certification of the Tukwila 205 levee expired a year ago, it is recommended that in the name of public safety, NWS follow the spirit of the instructions in EC 1110-2-6067 pertaining to the identification of a deficiency, and notifying FEMA and the levee sponsor of this potential safety issue with the Tukwila 205 levee.

6. The POC for additional information is Karl Eriksen, Hydraulic Engineering Section, 206-764-6892, *karl.w.eriksen@usace.army.mil*.

Karl Eriksen, P.E.
Senior Hydraulic Engineer

APPENDIX B. Geotechnical Analyses and Supporting Data

Material Properties from Slope Stability Model (Properties are used for all sites.) Note: Total Cohesion and Total Phi values are necessary for performing Rapid Drawdown Analysis. Negligible values were selected for rock materials that are not cohesive when wet.

Existing Embankment

Model: Mohr-Coulomb

Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °
Total Cohesion: 2 psf
Total Phi: 22 °

New Embankment

Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 36 °
Total Cohesion: 2 psf
Total Phi: 22 °

Riprap

Model: Mohr-Coulomb
Unit Weight: 150 pcf
Cohesion': 0 psf
Phi': 37 °
Total Cohesion: 0.1 psf
Total Phi: 36.9 °

Quarry Spalls

Model: Mohr-Coulomb
Unit Weight: 145 pcf
Cohesion': 0 psf
Phi': 37 °
Total Cohesion: .1 psf
Total Phi: 36.9 °

Riverbed
Model: Mohr-Coulomb
Unit Weight: 110 pcf
Cohesion': 300 psf
Phi': 33 °

Total Cohesion: 400 psf
Total Phi: 25 °

Topsoil

Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 100 psf
Phi': 33°
Total Cohesion: 250 psf
Total Phi: 25 °

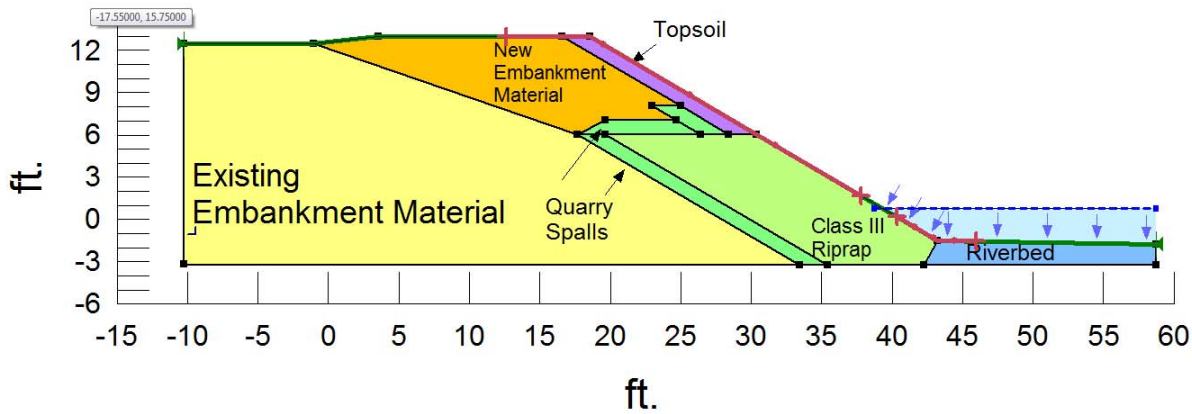


Figure 10. Slope stability model setup for Site 1

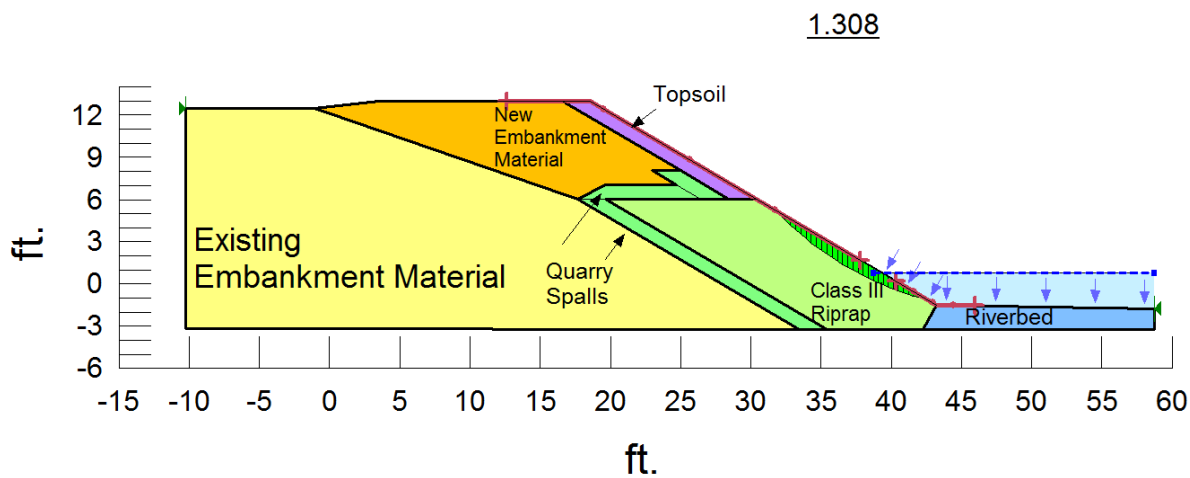


Figure 11. Slope stability model results for Site 1- Factor of Safety for Steady-State Condition - 1.308

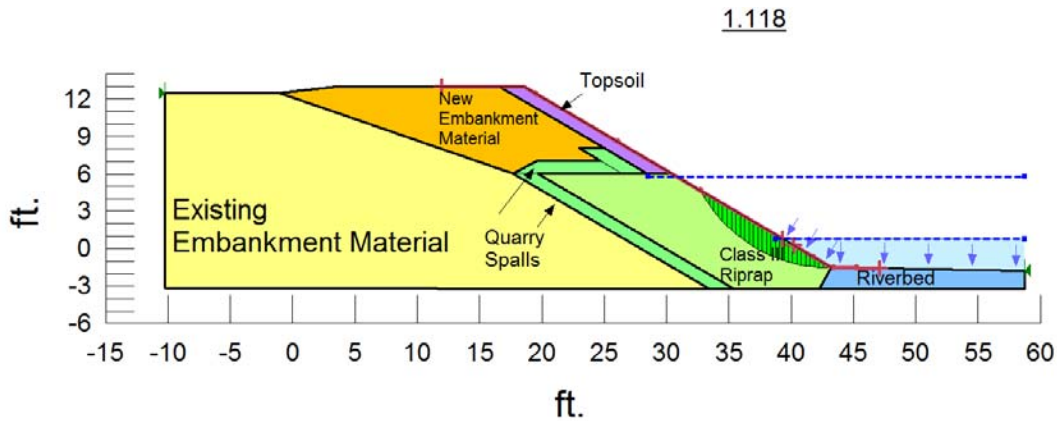


Figure 12. Slope stability model results for Site 1 – Factor of Safety for Rapid Drawdown – 1.118

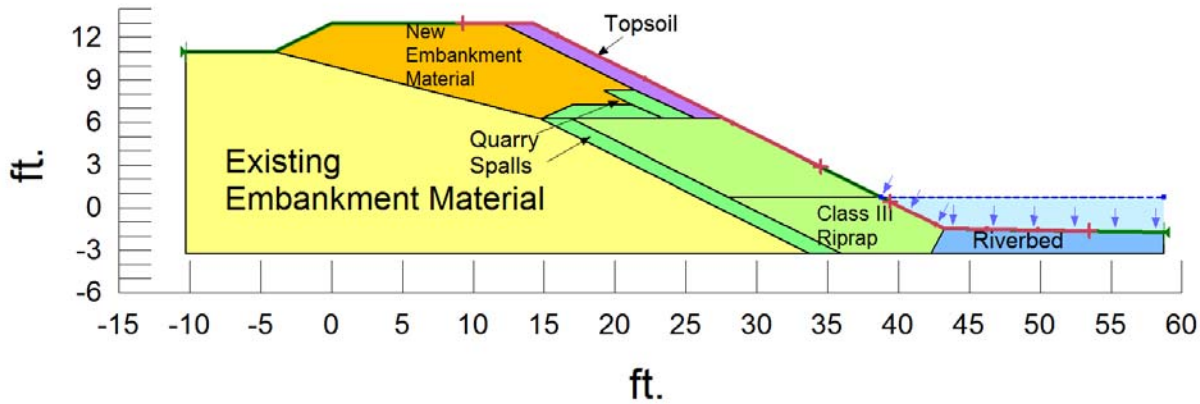


Figure 13. Slope stability model setup for Sites 2 & 3

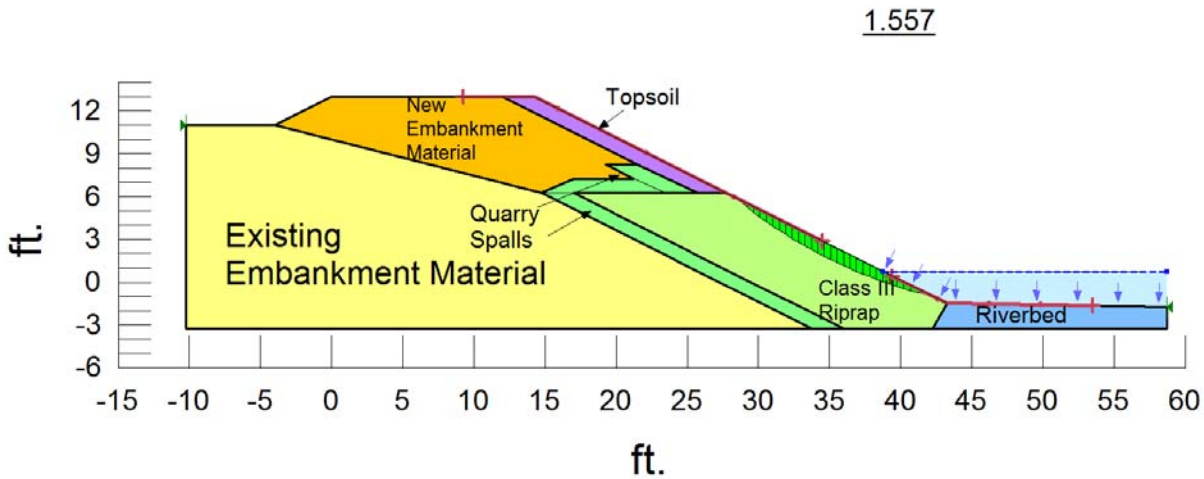


Figure 14. Slope stability model results for Sites 2 & 3 – Factor of Safety for Steady-State Condition – 1.557

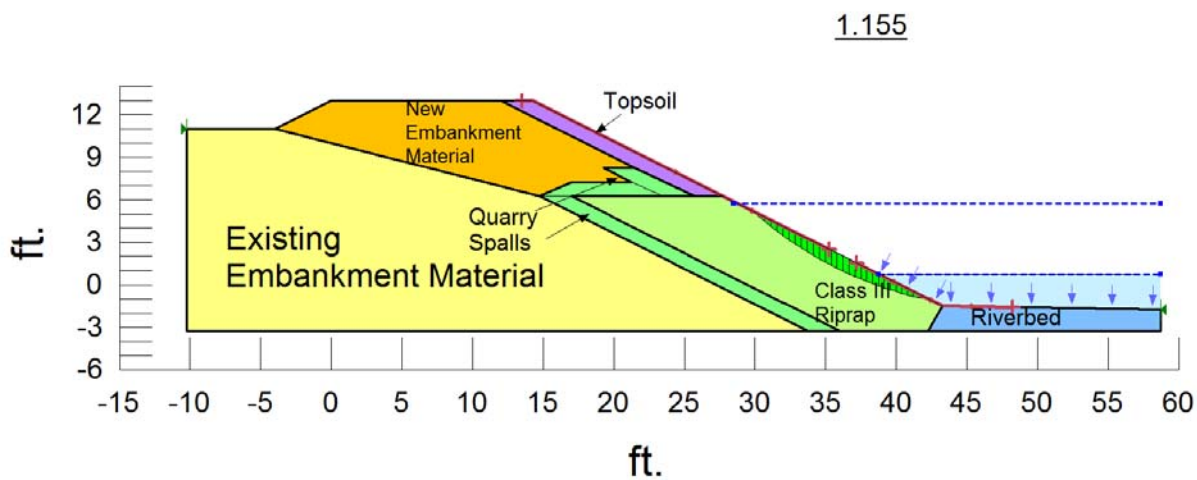


Figure 15. Slope stability model results for Sites 2 & 3 – Factor of Safety for Rapid Drawdown – 1.155

APPENDIX C. Civil Design Supporting Data

U.S. ARMY CORPS OF ENGINEERS		
PROJECT: **Dykstra Levee Rehab**	COMPUTED BY: Michael Peele	DATE: 3/20/2015
SUBJECT: **Earthwork Quantities**	CHECKED BY: Jeff Tribbett	SHT. 1 of 1

Site 1 Totals

Normal Cut:	1250	CY
Topsoil:	63	CY
Aggregate Base Couse:	5	CY
Class III Riprap:	650	CY
Quarry Spalls	234	CY

Site 2 Totals

Normal Cut:	4760	CY
Topsoil:	258	CY
Aggregate Base Couse:	85	CY
Class III Riprap:	2340	CY
Quarry Spalls	752	CY

Site 3 Totals

Normal Cut:	2920	CY
Topsoil:	150	CY
Aggregate Base Couse:	50	CY
Class III Riprap:	1530	CY
Quarry Spalls	463	CY

Applying 5% losses factor to all materials.
Applying a 15% bulking and 5% losses factor to Cut.
Applying a 45% bulking and 5% losses factor to Topsoil.

Project Totals (with bulking and losses)

Material:	Factor:	Quantity	
Normal Cut:	1.2	10716	CY
Topsoil:	1.5	706.5	CY
Aggregate Base Couse:	1.05	147	CY
Class III Riprap:	1.05	4746	CY
Quarry Spalls	1.05	1521.45	CY

Volumes Report

Report Created: 3/12/2015
Time: 9:37am

Cross Section Set Name: Site 1_1
Alignment Name: Site 1

Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Station	Type	Area	Volume	Factor	Adjusted Volume	Included in Mass Ordinate?	Mass Ordinate
0+00.00							0
	Normal Cut:	300.4	0	1	0	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	159.4	0	1	0	No	
	Wearing:	5	0	1	0	No	
	Topsoil:	15	0	1	0	No	
	Quarry Spalls:	56.5	0	1	0	No	
0+10.00							112.2
	Normal Cut:	305.3	112.2	1	112.2	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	159.4	59.1	1	59.1	No	
	Wearing:	5	1.8	1	1.8	No	
	Topsoil:	15	5.5	1	5.5	No	

	Quarry Spalls:	56.5	20.9	1	20.9	No	
0+20.00							225.5
	Normal Cut:	306.9	113.4	1	113.4	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	159.4	59.1	1	59.1	No	
	Wearing:	5	1.8	1	1.8	No	
	Topsoil:	15	5.5	1	5.5	No	
	Quarry Spalls:	56.6	20.9	1	20.9	No	
0+30.00							339.4
	Normal Cut:	308	113.9	1	113.9	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	160.2	59.2	1	59.2	No	
	Wearing:	5	1.8	1	1.8	No	
	Topsoil:	15	5.5	1	5.5	No	
	Quarry Spalls:	56.8	21	1	21	No	
0+40.00							454
	Normal Cut:	311.1	114.7	1	114.7	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	161.3	59.5	1	59.5	No	
	Wearing:	5	1.8	1	1.8	No	
	Topsoil:	15	5.6	1	5.6	No	
	Quarry Spalls:	57	21.1	1	21.1	No	

0+50.00						570.9
	Normal Cut:	319.7	116.8	1	116.8	Yes
	Normal Fill:	0	0	1	0	Yes
	Added Cut:		0	1	0	Yes
	Added Fill:		0	1	0	Yes
	Riprap:	162.3	59.9	1	59.9	No
	Wearing:	5	1.8	1	1.8	No
	Topsoil:	15	5.6	1	5.6	No
	Quarry Spalls:	57.3	21.2	1	21.2	No
0+60.00						686.9
	Normal Cut:	307.1	116.1	1	116.1	Yes
	Normal Fill:	0	0	1	0	Yes
	Added Cut:		0	1	0	Yes
	Added Fill:		0	1	0	Yes
	Riprap:	159	59.5	1	59.5	No
	Wearing:	5	1.8	1	1.8	No
	Topsoil:	15	5.6	1	5.6	No
	Quarry Spalls:	56.7	21.1	1	21.1	No
0+70.00						798.5
	Normal Cut:	295.2	111.5	1	111.5	Yes
	Normal Fill:	0	0	1	0	Yes
	Added Cut:		0	1	0	Yes
	Added Fill:		0	1	0	Yes
	Riprap:	154.1	58	1	58	No
	Wearing:	5	1.8	1	1.8	No
	Topsoil:	15	5.6	1	5.6	No
	Quarry Spalls:	55.7	20.8	1	20.8	No
0+80.00						903.9
	Normal Cut:	274	105.4	1	105.4	Yes

Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	148.6	56	1	56	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	
Quarry Spalls:	54.7	20.5	1	20.5	No	
0+90.00						1006.1
Normal Cut:	278.1	102.2	1	102.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	148.6	55	1	55	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	
Quarry Spalls:	54.8	20.3	1	20.3	No	
1+00.00						1110.8
Normal Cut:	287.5	104.7	1	104.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	148.6	55	1	55	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	
Quarry Spalls:	54.8	20.3	1	20.3	No	
1+10.00						1218.2
Normal Cut:	292.4	107.4	1	107.4	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	

Added Fill:		0	1	0	Yes	
Riprap:	148.6	55	1	55	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	
Quarry Spalls:	54.9	20.3	1	20.3	No	
1+12.63						1246.7
Normal Cut:	293.9	28.5	1	28.5	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	148.6	14.5	1	14.5	No	
Wearing:	5	0.5	1	0.5	No	
Topsoil:	15	1.5	1	1.5	No	
Quarry Spalls:	54.9	5.3	1	5.3	No	

Totals:

Normal Cut:	1246.7	1246.7	Yes
Normal Fill:	0	0	Yes
Added Cut:	0	0	Yes
Added Fill:	0	0	Yes
Riprap:	649.9	649.9	No
Wearing:	20.6	20.6	No
Topsoil:	62.6	62.6	No
Quarry Spalls:	233.7	233.7	No

Volumes Report

Report Created: 3/12/2015
Time: 9:40am

Cross Section Set Name: Site 2_1
Alignment Name: Site 2

Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Station	Type	Area	Volume	Factor	Adjusted Volume	Included in Mass Ordinate?	Mass Ordinate
0+00.00							0
	Normal Cut:	311.9	0	1	0	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	159.2	0	1	0	No	
	Levee:	21.5	0	1	0	No	
	Wearing:	5	0	1	0	No	
	Topsoil:	15.8	0	1	0	No	
	Quarry Spalls:	47.9	0	1	0	No	
0+10.00							119
	Normal Cut:	330.7	119	1	119	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	158.3	58.8	1	58.8	No	
	Levee:	21.4	7.9	1	7.9	No	

Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.8	5.8	1	5.8	No	
Quarry Spalls:	47.7	17.7	1	17.7	No	
0+20.00						240.7
Normal Cut:	326.3	121.7	1	121.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	157.3	58.4	1	58.4	No	
Levee:	21.2	7.9	1	7.9	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.7	5.8	1	5.8	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+30.00						360.8
Normal Cut:	322.5	120.2	1	120.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.4	58.1	1	58.1	No	
Levee:	21.1	7.8	1	7.8	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.7	5.8	1	5.8	No	
Quarry Spalls:	47.4	17.6	1	17.6	No	
0+40.00						479.8
Normal Cut:	320.1	119	1	119	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	155.4	57.7	1	57.7	No	

Levee:	21	7.8	1	7.8	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.7	5.8	1	5.8	No	
Quarry Spalls:	47.1	17.5	1	17.5	No	
0+50.00						596.6
Normal Cut:	310.8	116.8	1	116.8	Yes	
Normal Fill:	0.3	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	154.4	57.4	1	57.4	No	
Levee:	20.8	7.7	1	7.7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.7	5.8	1	5.8	No	
Quarry Spalls:	46.9	17.4	1	17.4	No	
0+60.00						712.8
Normal Cut:	317.3	116.3	1	116.3	Yes	
Normal Fill:	0.1	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	153.5	57	1	57	No	
Levee:	20.7	7.7	1	7.7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.6	5.8	1	5.8	No	
Quarry Spalls:	46.7	17.3	1	17.3	No	
0+70.00						830.9
Normal Cut:	320.3	118.1	1	118.1	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	

Riprap:	152.2	56.6	1	56.6	No	
Levee:	20.6	7.6	1	7.6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.6	5.8	1	5.8	No	
Quarry Spalls:	46.5	17.3	1	17.3	No	
0+80.00						948.9
Normal Cut:	316.8	118	1	118	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	151.2	56.2	1	56.2	No	
Levee:	20.4	7.6	1	7.6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.6	5.8	1	5.8	No	
Quarry Spalls:	46.3	17.2	1	17.2	No	
0+90.00						1064.7
Normal Cut:	308.4	115.8	1	115.8	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	150.3	55.8	1	55.8	No	
Levee:	20.3	7.5	1	7.5	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.5	5.8	1	5.8	No	
Quarry Spalls:	46.1	17.1	1	17.1	No	
1+00.00						1176.5
Normal Cut:	295.5	111.8	1	111.8	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	

Added Fill:		0	1	0	Yes	
Riprap:	149.3	55.5	1	55.5	No	
Levee:	20.1	7.5	1	7.5	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.5	5.7	1	5.7	No	
Quarry Spalls:	45.9	17	1	17	No	
1+10.00						1285.6
Normal Cut:	293.9	109.1	1	109.1	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	148.3	55.1	1	55.1	No	
Levee:	20	7.4	1	7.4	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.5	5.7	1	5.7	No	
Quarry Spalls:	45.7	17	1	17	No	
1+20.00						1393.3
Normal Cut:	287.7	107.7	1	107.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	147.3	54.8	1	54.8	No	
Levee:	19.9	7.4	1	7.4	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.4	5.7	1	5.7	No	
Quarry Spalls:	45.5	16.9	1	16.9	No	
1+30.00						1505.3
Normal Cut:	317	112	1	112	Yes	
Normal Fill:	0	0	1	0	Yes	

Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	146.4	54.4	1	54.4	No	
Levee:	19.7	7.3	1	7.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.4	5.7	1	5.7	No	
Quarry Spalls:	45.3	16.8	1	16.8	No	
1+40.00						1622
Normal Cut:	313.5	116.7	1	116.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	145.4	54	1	54	No	
Levee:	19.6	7.3	1	7.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.4	5.7	1	5.7	No	
Quarry Spalls:	45.1	16.7	1	16.7	No	
1+50.00						1736.1
Normal Cut:	302.4	114.1	1	114.1	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	144.4	53.7	1	53.7	No	
Levee:	19.5	7.2	1	7.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.4	5.7	1	5.7	No	
Quarry Spalls:	44.9	16.7	1	16.7	No	
1+60.00						1845.2
Normal Cut:	287.1	109.2	1	109.2	Yes	

Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	143.4	53.3	1	53.3	No	
Levee:	19.3	7.2	1	7.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	44.7	16.6	1	16.6	No	
1+70.00						1950.6
Normal Cut:	281.8	105.4	1	105.4	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	142.4	52.9	1	52.9	No	
Levee:	19.2	7.1	1	7.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	44.5	16.5	1	16.5	No	
1+80.00						2054
Normal Cut:	276.5	103.4	1	103.4	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	141.5	52.6	1	52.6	No	
Levee:	19.1	7.1	1	7.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	44.3	16.4	1	16.4	No	
1+90.00						2154.7

Normal Cut:	267.3	100.7	1	100.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	140.5	52.2	1	52.2	No	
Levee:	18.9	7	1	7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.7	1	5.7	No	
Quarry Spalls:	44.1	16.4	1	16.4	No	
2+00.00						2254.2
Normal Cut:	269.8	99.5	1	99.5	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	139.5	51.9	1	51.9	No	
Levee:	18.8	7	1	7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	43.9	16.3	1	16.3	No	
2+10.00						2355.6
Normal Cut:	278.1	101.5	1	101.5	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	138.5	51.5	1	51.5	No	
Levee:	18.7	6.9	1	6.9	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	43.7	16.2	1	16.2	No	

2+20.00						2458.3
Normal Cut:	276.1	102.6	1	102.6	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	137.6	51.1	1	51.1	No	
Levee:	18.5	6.9	1	6.9	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	43.5	16.1	1	16.1	No	
2+30.00						2559.4
Normal Cut:	270	101.1	1	101.1	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	136.6	50.8	1	50.8	No	
Levee:	18.4	6.8	1	6.8	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.1	5.6	1	5.6	No	
Quarry Spalls:	43.3	16.1	1	16.1	No	
2+40.00						2655.1
Normal Cut:	247	95.7	1	95.7	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	135.9	50.5	1	50.5	No	
Levee:	18.2	6.8	1	6.8	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.1	5.6	1	5.6	No	
Quarry Spalls:	43.1	16	1	16	No	

2+50.00						2746.2
Normal Cut:	245.4	91.2	1	91.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	135	50.2	1	50.2	No	
Levee:	18.1	6.7	1	6.7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.1	5.6	1	5.6	No	
Quarry Spalls:	42.9	15.9	1	15.9	No	
2+60.00						2833.2
Normal Cut:	224.3	87	1	87	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	134	49.8	1	49.8	No	
Levee:	18	6.7	1	6.7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	
Quarry Spalls:	42.7	15.9	1	15.9	No	
2+70.00						2915.5
Normal Cut:	220.2	82.3	1	82.3	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	133	49.4	1	49.4	No	
Levee:	17.8	6.6	1	6.6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	

Quarry Spalls:	42.5	15.8	1	15.8	No	
2+80.00						2996.1
Normal Cut:	215.4	80.7	1	80.7	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	132.1	49.1	1	49.1	No	
Levee:	17.7	6.6	1	6.6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.6	1	5.6	No	
Quarry Spalls:	42.3	15.7	1	15.7	No	
2+90.00						3075.4
Normal Cut:	212.9	79.3	1	79.3	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	131.1	48.7	1	48.7	No	
Levee:	17.6	6.5	1	6.5	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15	5.5	1	5.5	No	
Quarry Spalls:	42.1	15.6	1	15.6	No	
3+00.00						3154.6
Normal Cut:	215.1	79.3	1	79.3	Yes	
Normal Fill:	0.3	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	130.1	48.4	1	48.4	No	
Levee:	17.4	6.5	1	6.5	No	
Wearing:	5	1.8	1	1.8	No	

Topsoil:	14.9	5.5	1	5.5	No	
Quarry Spalls:	41.9	15.6	1	15.6	No	
3+10.00						3238.7
Normal Cut:	239.9	84.3	1	84.3	Yes	
Normal Fill:	0.3	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	129.2	48	1	48	No	
Levee:	17.3	6.4	1	6.4	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.9	5.5	1	5.5	No	
Quarry Spalls:	41.7	15.5	1	15.5	No	
3+20.00						3328.9
Normal Cut:	247.3	90.2	1	90.2	Yes	
Normal Fill:	0.1	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	128.2	47.7	1	47.7	No	
Levee:	17.2	6.4	1	6.4	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.9	5.5	1	5.5	No	
Quarry Spalls:	41.5	15.4	1	15.4	No	
3+30.00						3419.1
Normal Cut:	239.6	90.2	1	90.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.4	1	47.4	No	
Levee:	17	6.3	1	6.3	No	

Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.8	5.5	1	5.5	No	
Quarry Spalls:	41.4	15.3	1	15.3	No	
3+40.00						3507.3
Normal Cut:	236.8	88.2	1	88.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	16.9	6.3	1	6.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.8	5.5	1	5.5	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
3+50.00						3594.5
Normal Cut:	234.1	87.2	1	87.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	16.8	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.8	5.5	1	5.5	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
3+60.00						3681.1
Normal Cut:	233.5	86.6	1	86.6	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	

Levee:	16.6	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.8	5.5	1	5.5	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
3+70.00						3771.1
Normal Cut:	252.8	90	1	90	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	16.5	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.7	5.5	1	5.5	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
3+80.00						3869.8
Normal Cut:	280	98.7	1	98.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	16.4	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.7	5.5	1	5.5	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
3+90.00						3978.5
Normal Cut:	306.8	108.7	1	108.7	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	

Riprap:	127.5	47.2	1	47.2	No	
Levee:	16.2	6	1	6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.7	5.4	1	5.4	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
4+00.00						4096.1
Normal Cut:	329.3	117.8	1	117.8	Yes	
Normal Fill:	0.6	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	16.1	6	1	6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.6	5.4	1	5.4	No	
Quarry Spalls:	41.3	15.3	1	15.3	No	
4+10.00						4216.7
Normal Cut:	322.7	120.7	1	120.7	Yes	
Normal Fill:	0.6	0.2	1	0.2	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	15.9	5.9	1	5.9	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.6	5.4	1	5.4	No	
Quarry Spalls:	41.2	15.3	1	15.3	No	
4+20.00						4332.8
Normal Cut:	305.3	116.3	1	116.3	Yes	
Normal Fill:	0.4	0.2	1	0.2	Yes	
Added Cut:		0	1	0	Yes	

Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	15.8	5.9	1	5.9	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.6	5.4	1	5.4	No	
Quarry Spalls:	41.2	15.3	1	15.3	No	
4+30.00						4440.8
Normal Cut:	278.6	108.1	1	108.1	Yes	
Normal Fill:	0.1	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	15.7	5.8	1	5.8	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.6	5.4	1	5.4	No	
Quarry Spalls:	41.2	15.3	1	15.3	No	
4+40.00						4539.9
Normal Cut:	256.4	99.1	1	99.1	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	15.5	5.8	1	5.8	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.5	5.4	1	5.4	No	
Quarry Spalls:	41.2	15.3	1	15.3	No	
4+50.00						4631.5
Normal Cut:	238.2	91.6	1	91.6	Yes	
Normal Fill:	0	0	1	0	Yes	

Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	127.5	47.2	1	47.2	No	
Levee:	15.4	5.7	1	5.7	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	14.5	5.4	1	5.4	No	
Quarry Spalls:	41.2	15.3	1	15.3	No	
4+60.00						4750.7
Normal Cut:	405.3	119.2	1	119.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	0	23.6	1	23.6	No	
Levee:	9.7	4.6	1	4.6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	13.3	5.1	1	5.1	No	
Quarry Spalls:	76.4	21.8	1	21.8	No	
4+60.51						4758.3
Normal Cut:	406.6	7.6	1	7.6	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	0	0	1	0	No	
Levee:	9.7	0.2	1	0.2	No	
Wearing:	5	0.1	1	0.1	No	
Topsoil:	13.3	0.2	1	0.2	No	
Quarry Spalls:	78.2	1.4	1	1.4	No	

Totals:

Normal Cut:	4759.6	4759.6	Yes
Normal Fill:	1.4	1.4	Yes
Added Cut:	0	0	Yes
Added Fill:	0	0	Yes
Riprap:	2339	2339	No
Levee:	312.4	312.4	No
Wearing:	84.4	84.4	No
Topsoil:	257.9	257.9	No
Quarry Spalls:	751.7	751.7	No

Volumes Report

Report Created: 3/12/2015
Time: 9:41am

Cross Section Set Name: Site 3
Alignment Name: Site 3

Input Grid Factor: 1

Note: All units in this report are in feet, square feet and cubic yards unless specified otherwise.

Station	Type	Area	Volume	Factor	Adjusted Volume	Included in Mass Ordinate?	Mass Ordinate
0+00.00							0
	Normal Cut:	356.4	0	1	0	Yes	
	Normal Fill:	0	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	156.7	0	1	0	No	
	Levee:	16.2	0	1	0	No	
	Wearing:	5	0	1	0	No	
	Topsoil:	15.2	0	1	0	No	
	Quarry Spalls:	47.5	0	1	0	No	
0+10.00							132.4
	Normal Cut:	358.9	132.5	1	132.5	Yes	
	Normal Fill:	0.1	0	1	0	Yes	
	Added Cut:		0	1	0	Yes	
	Added Fill:		0	1	0	Yes	
	Riprap:	156.7	58	1	58	No	
	Levee:	16.2	6	1	6	No	

Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+20.00						265.4
Normal Cut:	358.9	132.9	1	132.9	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.3	6	1	6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+30.00						399.2
Normal Cut:	364	133.9	1	133.9	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.3	6	1	6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+40.00						535
Normal Cut:	369.1	135.8	1	135.8	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	

Levee:	16.3	6	1	6	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+50.00						671.3
Normal Cut:	367.3	136.4	1	136.4	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.4	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+60.00						808.1
Normal Cut:	372	136.9	1	136.9	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.4	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+70.00						945
Normal Cut:	367.5	136.9	1	136.9	Yes	
Normal Fill:	0.2	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	

Riprap:	156.7	58	1	58	No	
Levee:	16.4	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+80.00						1080.6
Normal Cut:	365.1	135.7	1	135.7	Yes	
Normal Fill:	0.4	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.5	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
0+90.00						1214.2
Normal Cut:	357.3	133.8	1	133.8	Yes	
Normal Fill:	0.1	0.1	1	0.1	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.5	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+00.00						1344.1
Normal Cut:	344.3	129.9	1	129.9	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	

Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.5	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+10.00						1472.3
Normal Cut:	348	128.2	1	128.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.5	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.2	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+20.00						1600.2
Normal Cut:	342.7	127.9	1	127.9	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.6	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.6	1	5.6	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+30.00						1726
Normal Cut:	336.2	125.7	1	125.7	Yes	
Normal Fill:	0	0	1	0	Yes	

Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.6	6.1	1	6.1	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+40.00						1848.7
Normal Cut:	326.9	122.8	1	122.8	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.6	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+50.00						1965.2
Normal Cut:	302.3	116.5	1	116.5	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.7	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+60.00						2076.6
Normal Cut:	299	111.3	1	111.3	Yes	

Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.7	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+70.00						2186
Normal Cut:	291.7	109.4	1	109.4	Yes	
Normal Fill:	0.1	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.7	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+80.00						2293.6
Normal Cut:	289.7	107.7	1	107.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.8	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
1+90.00						2397.7

Normal Cut:	272.3	104.1	1	104.1	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.8	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
2+00.00						2494.1
Normal Cut:	248.6	96.5	1	96.5	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.8	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
2+10.00						2579.5
Normal Cut:	212.5	85.4	1	85.4	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.9	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	

2+20.00						2651.7
Normal Cut:	177.3	72.2	1	72.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.9	6.2	1	6.2	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
2+30.00						2713.9
Normal Cut:	158.8	62.2	1	62.2	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.9	6.3	1	6.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
2+40.00						2772.7
Normal Cut:	158.4	58.7	1	58.7	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	16.9	6.3	1	6.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	

2+50.00						2834.1
Normal Cut:	173.1	61.4	1	61.4	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	17	6.3	1	6.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
2+60.00						2898.5
Normal Cut:	175	64.5	1	64.5	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	156.7	58	1	58	No	
Levee:	17	6.3	1	6.3	No	
Wearing:	5	1.8	1	1.8	No	
Topsoil:	15.3	5.7	1	5.7	No	
Quarry Spalls:	47.5	17.6	1	17.6	No	
2+66.04						2918.1
Normal Cut:	0	19.6	1	19.6	Yes	
Normal Fill:	0	0	1	0	Yes	
Added Cut:		0	1	0	Yes	
Added Fill:		0	1	0	Yes	
Riprap:	0	17.5	1	17.5	No	
Levee:	0	1.9	1	1.9	No	
Wearing:	0	0.6	1	0.6	No	
Topsoil:	0	1.7	1	1.7	No	

Quarry Spalls:	0	5.3	1	5.3	No

Totals:

Normal Cut:	2918.7	2918.7	Yes
Normal Fill:	0.6	0.6	Yes
Added Cut:	0	0	Yes
Added Fill:	0	0	Yes
Riprap:	1526.5	1526.5	No
Levee:	161.8	161.8	No
Wearing:	48.2	48.2	No
Topsoil:	148.7	148.7	No
Quarry Spalls:	462.9	462.9	No

APPENDIX D. 2014 Dykstra Project Information Report

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
SEATTLE DISTRICT
P.O. BOX 3755
SEATTLE, WA 98124-3755

REPLY TO ATTENTION OF

CENWS-OD-EM

MEMORANDUM FOR Commander, Northwestern Division U.S. Army Corps of Engineers
ATTN: CENWD-CM-OE

SUBJECT: Dykstra Levee Rehabilitation – City of Auburn, King County, Washington, GRN-02-14 – Request for project approval

1. Request project review / approval of the project enclosed herein.

DISTRICT REMARKS

PROJECT APPROVAL / FUNDING SUMMARY SHEET

Project Number	GRN-02-14
Category Code	910-320
Type Report	Rehabilitation
Event Name	March 2014 Storm
Event Date Start	March 2014
State	Washington
County	King
CWIS Number	146620
B/C Ratio	1,257 : 1

Construction Subtotal	$	1,550,000
S&A (6%)	$	93,000
Contingency (10%)	$	155,000
Total Construction Cost	$	1,798,000
Engineering & Design (6% Federal)	$	108,000
Total Project Costs	**$**	**1,906,000**
Federal Project Costs (80% Construction Cost + E&D)	$	1,546,000
Sponsor Project Costs (20% Construction Cost)	$	360,000
B/C Ratio		1,257 : 1

2. This memorandum summarizes information found in the enclosed Project Information Report. For additional information, please contact CPT Rex Broderick at (206) 316-3133.

FOR THE COMMANDER

For Francis E. Coffey
Chief, Operations Division

PROJECT INFORMATION REPORT
REHABILITATION OF FLOOD CONTROL WORKS
DYKSTRA LEVEE, CITY OF AUBURN, KING COUNTY, WASHINGTON
GRN-02-14

PART 1. PROJECT EXECUTIVE SUMMARY

PROJECT NAME: Dykstra Non-Federal Levee

PROJECT FUNDING CLASS: 320

PROJECT CWIS NUMBER : 146620

NON-FEDERAL SPONSOR: King County

LOCATION AND DESCRIPTION: The Dykstra levee is a non-federal levee, located along the left bank of the Green River. It extends from about river mile (RM) 30.8 to RM 31.9, in the City of Auburn, King County, Washington. It was constructed by King County in the early 1960s and is maintained by King County. The levee is composed of earthen material armored with riprap on the riverward side. The levee protects residential and commercial property and infrastructure.

DESCRIPTION OF DAMAGE: Three sections of the levee are flood damaged and currently provide a 1 yr level of protection. The length of damage is 850 feet. The major damage, on the downstream end of the levee, includes scour of the toe which has caused sloughing and a 2 foot vertical crack of the riverward levee slope to begin sloughing off. The other two damaged sites have approximately 300 feet and 400 feet sections of scour at the toe and embankments which left a 2-3 foot vertical face above the waterline. Damages were reported following recent high flows on 3/10/2014 of 9,090 cfs at USGS 12113000, Green River near Auburn, WA. This event is estimated to be a 2-yr return period, or about a 0.5 chance of exceedance for a given year.

PROPOSED REPAIR: The proposed repair includes replacement of approximately 850' of the riverward levee toe and slope embankment for three sections of this levee. The three levee sections will be graded to allow a 2H:1V slope and a 3 foot blanket and buried toe of class IV riprap armor rock. Soil lifts with willow plantings will likely be included. The proposed repair will return the damaged portions of the levee to the pre-flood 0.002 ACE (200 yr) for overtopping Level of Protection (LOP). The remainder of the levee and toe is assumed to be intact and provide a 200 yr level of protection which is consistent with overtopping. The site 1 repair, see Figure B-3, has a 42 inch corrugated metal pipe (CMP) culvert near the downstream end (see photos C-3 & C-4). The downstream tie-in will likely encroach on the culvert headwall. Consequently, the headwall, Tideflex gate, and about a 20 foot section of culvert will need to be replaced.

PROJECT INFORMATION REPORT
REHABILITATION OF FLOOD CONTROL WORKS
GRN-02-14

SUMMARIZED FINANCIAL AND ECONOMIC DATA :

Construction Subtotal	$	1,550,000
S&A (6%)	$	93,000
Contingency (10%)	$	155,000
Total Construction Cost	$	1,798,000
Engineering & Design (6% Federal)	$	108,000
Total Project Costs	**$**	**1,906,000**
Federal Project Costs (80% Construction Cost + E&D)	$	1,546,000
Sponsor Project Costs (20% Construction Cost)	$	360,000
Project Estimated Annual Benefits	$	104,304,000
B/C Ratio		**1,257 : 1**

POINT OF CONTACT: Doug Weber, CENWS-OD-EM, (206) 764-3406

PART 2. PROJECT REPORT

1. Project Identification.
   a. Project Name: Dykstra Non-Federal Levee
   b. Project Funding Class: 320
   c. Project CWIS Number: 146620

2. Project Authority.
   a. Classification: Non-Federal flood control levee designed to provide protection from periodic, recurring floods
   b. Authority: Unknown
   c. Estimated original cost of project: Unknown
   d. Construction completion date of the original project: 1963
   e. Additional information regarding major modification/improvements/betterments:

A repair was performed in 1976 of about 150' of the levee near the upstream end. The repair fixed the riverward slope and rock armoring. A rehab was done in 2008 that repaired about 300' of damaged levee toe and lost armor rock on the riverward slope. See Figure B-1 for past repair sites.

3. Sponsor.
   a. Sponsor Identification: King County
      POC for Sponsor: Tom Bean
      Phone: (206) 477-4638 (W)
      (206) 979-8270 (C)

   b. Application for Assistance:
      (1) Date of Issuance of District's public Notice: March 17, 2014
      (2) Date of NFS's written request: April 16, 2014

4. Project Location
   a. Town: City of Auburn
      County: King
      State: Washington
      Basin: Green
      Flood Source: Green River

Narrative: This levee is part of a system of levees along the Green River. Due to current damages, the project's level of protection has been reduced from 200 years to 1 year protection. The damaged project sections are located on the left bank of the Green River between river miles 30.8 and 31.9. See Appendix C for photographs of damage and Appendix B for location and vicinity maps, and typical cross sections for the proposed repair. Residential structures butt the levee and, in some locations, may inhibit or limit the use of large construction equipment.

5. Project Design: The riverside levee slope is 1.5H:1V to 2H:1V (Horizontal to Vertical) and the levee is approximately 12 feet in height, measured from the waterside toe. The levee top width varies from 15 to 20 feet. The landside of the levee is either level with or drops only slightly (about 3 feet) from the crown elevation. Original as-builts for this levee are unavailable. Armor was added to past repair sites (see Figure B-1) and toe rock was observed at various locations along the levee. Riprap was observed from approximate Station 9+00 to 21+00. The designed repair would replace damaged toe and embankment areas with levee material and a blanket of rock armor, and restore a gravel path to the crown. A cross-section is included in Appendix B.

6. Disaster Incident: Damages were reported following recent high flows of 9,090 cfs at USGS 12113000, Green River near Auburn, WA on 3/10/2014. This event is estimated to be a 2-yr return period, or about a 0.5 (50%) chance of exceedance for a given year.

7. Project Damages:

a. The high river flows caused scour and loss of embankment material and toe rock, which produced an unstable, oversteepened slope. This levee requires an emergency repair to restore flood protection.

b. The loss of scour protection has compromised the levee's pre-flood level of protection. The current LOP for this levee is a 1-year return period and corresponds to the point where damage would occur with some certainty if the levee provided no flood mitigation.

8. Project Performance:
The last pre-flood levee inspection was conducted in June 2013. There were no deficiencies or damage noted at the proposed repair sites in this PIR. The overall levee was found to be in unacceptable condition but the levee segment remains eligible in the

PL84-99 program due to King County's participation in the Corps' system wide improvement framework (SWIF) program. Although the current guidance would give the County two years to accomplish repairs, this levee will remain eligible for Federal assistance as long as the County continues progress in this program. Vegetation was the deficiency noted in the inspection report, and is the reason it is in the SWIF.The local sponsor performs periodic vegetation maintenance.

9. Project Repair Alternatives Considered:
Multiple alternatives were considered. The Repair to Pre-flood Level of Protection Alternative is the preferred alternative. A preliminary analysis has been performed on the following alternatives: All proposed structural repairs will restore the pre-flood 200 yr level of protection.

a. No Action Alternative:
The No-Action alternative was rejected due to the reduced level of protection and the increased likelihood of levee failure. The results of a failure would include extensive residential and commercial damages within Auburn, Washington.

b. Repair to Pre-Flood Level of Protection Alternative:
The repair includes rebuilding a total of approximately 850' levee embankment and toe on the riverward slope. The repair will reestablish the levee to the pre-flood level of protection by regrading the slope to 2H:1V and adding new armoring to protect the structure from scour. Site 1 has a 42-inch metal culvert with Tideflex duckbill gate and a concrete headwall. The culvert is not damaged, but the downstream transition will most likely encroach on the headwall. This will require that the precast concrete headwall, the Tideflow duckbill gate, and about a 20 foot section of culvert be replaced. See the design drawings in Appendix B.

c. Non-Structural Alternative:
This alternative would relocate all existing structures, utilities and other infrastructure within the damage area protected by the levee. This was not a viable alternative for our sponsor. The costs and low feasibility associated with this alternative were deemed too high for the level of benefit associated with this alternative.

10. Recommended Alternative:
The recommended alternative is: b. Repair to Pre-flood Level of Protection. The proposed repair will entail replacing a total of 850' of the levee toe and repairing the slope that has been damaged. Included in the total length is the transition required to meet the existing levee adjacent to the up and downstream segments. All governing regulation and pertaining requirements will need to be followed. See Appendix B for design drawings and maps, and Appendix C for photos. Confirmation of the preferred alternative and finalization of the design, including NEPA/ESA recommendations, will occur during the Engineering and Design phase and prior to construction.

11. Real Estate.

Lands, Easements, Rights-of-Ways, Relocation, and Disposal (LERRD's)

The project is located in the City of Auburn, WA in Sections 7/8, Township 21 North, Range 5 East, Willamette Meridian, in King County, Washington. The Dykstra Levee Rehabilitation Project would repair 3 separate sites consisting of approximately 850 LF to address toe erosion and bank sloughing (See Appendix B).

In order to proceed with the rehabilitation effort, the NFS must make the required local project lands available prior to solicitation for the construction contract. See the proposed project schedule under Section 15 of this report.

To meet the real estate requirements, the Public Sponsor will need to demonstrate that it has the below minimum real property interests for the entire Dykstra Levee Rehabilitation Project:

> PERPETUAL FLOOD PROTECTION LEVEE EASEMENT ESTATE
> A perpetual and assignable right and easement in the land delineated on the attached location map, Exhibit_____, by this reference made a part hereof, to construct, maintain, repair, operate, patrol and replace a flood protection levee, including all appurtenances thereto; reserving, however, to the owners, their heirs and assigns, all such rights and privileges in the land as may be used without interfering with or abridging the rights and easement hereby acquired.

Proposed access (both ingress and egress) to the Rehabilitation Effort site is available from public streets onto the levee. The Public Sponsor will need to demonstrate that it has the below real property interests for access to the levee easement footprint for construction, operation and maintenance of the Dykstra Levee Rehabilitation Project.

> PERPETUAL ROAD EASEMENT
> A perpetual and assignable easement and right-of-way in, on, over and across the land delineated on the attached location map, Figures _____, for the location, construction, operation, maintenance, alteration and replacement of (a) road(s) and appurtenances thereto; together with the right to trim, cut, fell and remove therefrom all trees, underbrush, obstructions and other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the grantors, their heirs and assigns, the right to cross over or under the right-of-way as access to their adjoining land; subject, however, to existing easements for public roads and highways, public utilities, railroads and pipelines.

A temporary work area for construction staging is proposed within the Levee Easement. The Public Sponsor will need to demonstrate that it has the below real property interests for the proposed temporary work area.

TEMPORARY WORK AREA EASEMENT

A temporary easement and right-of-way in, on, over, and across the land delineated on the attached location map, Figures _____, for a period not to exceed_____, beginning with date possession of the land is granted to the Grantee for use by the United States, its representatives, agents, and contractors as a work area, including the right to deposit fill thereon, move, store, and remove equipment and supplies, and erect and remove temporary structures on the land, and to perform any other work necessary and incident to the construction of Dykstra Levee Rehabilitation Project Job No. GRN-02-14, together with the right to trim, cut, fell, and remove there from all trees, underbrush, obstructions, and any other vegetation, structures, or obstacles within the limits of the right-of-way; reserving, however, to the landowners, their heirs and assigns, all such rights and privileges as may be used without interfering with or abridging the rights and easement hereby acquired; subject, however, to existing easements for public roads.

The Public Sponsor may also need to provide a suitable disposal site by acquiring a temporary disposal area (using the above temporary work area easement); however, if the Public Sponsor is unable to provide a suitable disposal area, then the material will be taken to a commercial site for disposal.

The final location of temporary work area easements and disposal sites to support the construction of the Rehabilitation Effort, including access routes for ease of construction, will be determined in the next phase – Engineering & Design (E&D). Also as part of the land certification process for the levee rehabilitation effort and the entire Dykstra Levee Rehabilitation Project, the Public Sponsor will need to provide title reports, not more than 90 days old at the time of land certification demonstrating its interest in the Levee Project lands.

Any questions regarding types of property interests needed for the proposed project should be coordinated with COE, Real Estate Division.

12. Economic Evaluation

The objective of the economic evaluation is to determine if the project is economically justified.
The economic analysis is conducted in accordance with ER and EP 500-1-1. Some key points are as follows:

a. Discount Rate. Economic justification analysis will use the current Federal discount rate for water resources evaluation. Currently the discount rate is 3.5%.

b. Level of Detail. The benefits of project rehabilitation are determined by comparison of the with and without project conditions. The economic analysis will be prepared in level of detail commensurate with the complexity of the project. Also in the

analysis, the greater the effect a particular benefit item has on project justification, the greater the level of detail of its evaluation. It is not intended that the analyses for rehabilitation projects be exhaustive, but should provide sufficient data to document the steps used in formulating the proposed plan of rehabilitation.

c. Period of Analysis. The same period of time over which all project costs and benefits are analyzed is used for all alternatives. The period of analysis for rehabilitation work should not exceed the remaining physical life of the entire project. Any exception to the above will require justification in the PIR.

1) Federal Projects. The economic life of federally constructed projects shall be the shortest time period determined by the following criteria:

a. Fifty years.

b. The degree of protection afforded by the project in the rehabilitated condition.

c. The anticipated remaining life of the project assuming ordinary maintenance without major component rehabilitation (e.g. pumping plants, earth fill levees, riprap protection, etc.)

2) Non-Federal Agricultural Projects. Ten years, or the degree of protection provided, whichever is less.

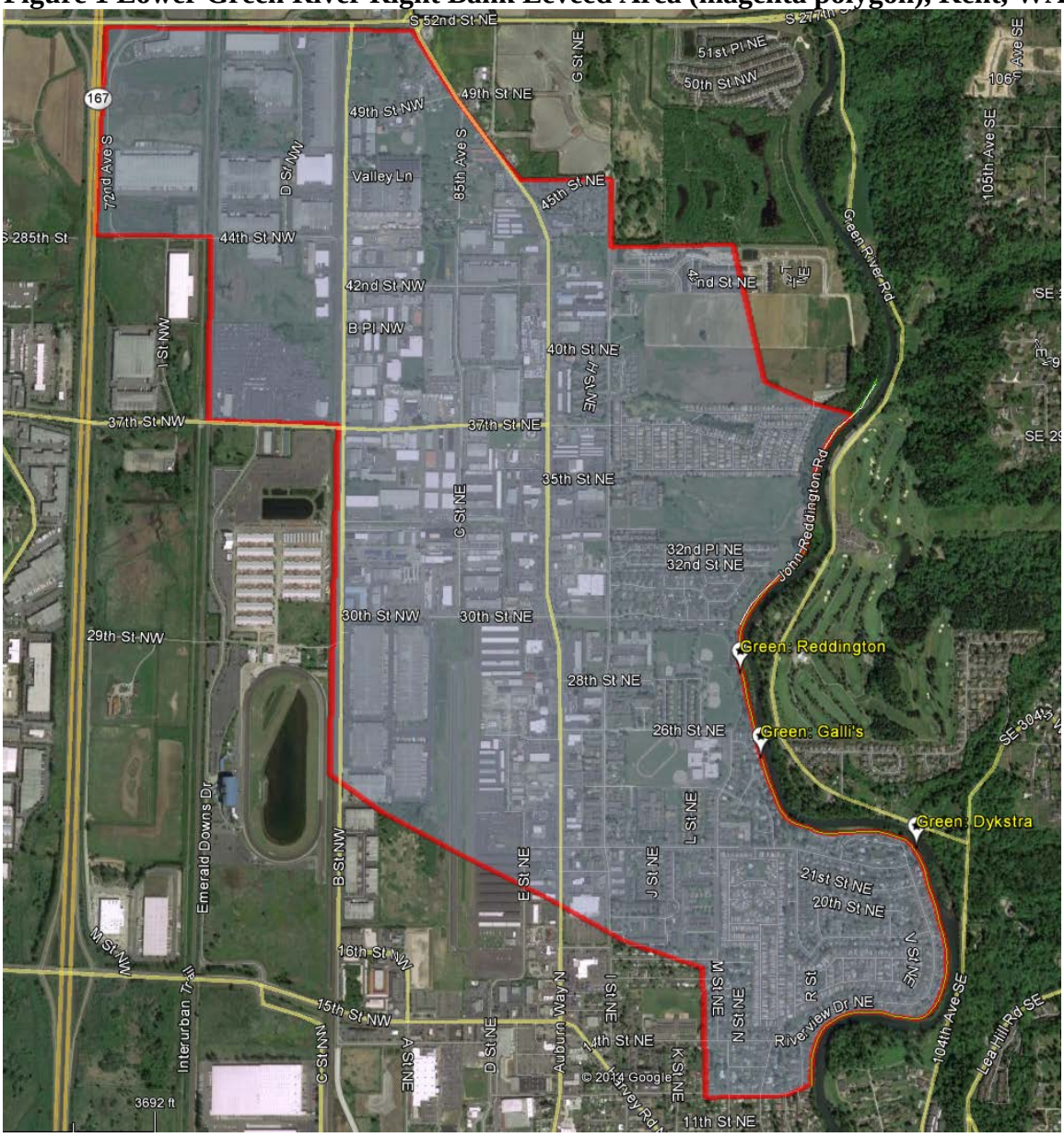
3) Non-Federal Urban Projects. Use same criteria as for Federal projects.

Based on the criteria in c. (1-3), the Period of Analysis for this analysis will be fifty years.

Location: The Dykstra Levee is a segment of the Galis/Dykstra/Reddington Levee system. It is on the left bank of the Green River, beginning about two and a half miles downstream of the Hwy 18 Bridge and extending another two miles downstream.

Protected area: The leveed or protected area extends about a mile to the east is about 2.26 square miles of highly developed warehousing, light industrial, retail, and about a third of it is residential. According to the Levee Screening Tool (LST), which pulls its data from the Census, daytime population is estimated at about 7,200; night time about 5,700. The LST also estimates about 1780 structures with a value of about $886M. See Figure 1.2.

Figure 1 Lower Green River Right Bank Leveed Area (magenta polygon), Kent, WA



a. <u>Without-Project Condition:</u> NWS engineering staff has estimated that the levee's level of protection has been reduced from 200 years (.005 annual exceedance probability) to a 1 year or annual event (.9999 annual exceedance probability). According to the Levee Screening Tool (LST), an event that overtops the levee (maximum level of protection) is about a 200-year event, which would inundate over 1400 acres and 1780 structures valued at $885M to depths of over 21 feet.

<u>With-Project Condition:</u> Repair of the levee would restore the estimated level of protection to approximately a 200-year event. Therefore, flooding of the residential and

commercial structures and inventory would not be expected before the 200-year event for the with-project condition.

b. Benefits Evaluation. In accordance with ER 500-1-1, the economic analysis is prepared to a level of detail sufficient to demonstrate a high probability that the annualized economic benefits of the repair exceed the annualized costs.

This levee has been screened by the levee screening process and the LST has information about the extent of the protected area, property values, and inundation depths that has been reviewed extensively.

The LST includes a graph with information about population, number of structures, area (in square miles), and structure value associated with ground and water surface elevations. Figure 2 below is a screen shot from the LST of the Dykstra levee screening.

Figure 2 Dykstra Elevations vs. Property values

Table 1 tabulates the characteristics by ground elevation.

Table 1 Leveed Area Characteristics

Approx Ground Elevation	Flood Plain Area (Square Miles)	Est Pop (Day)	Number of structures	Value of Structures
40 (invert)	0	0	0	0
52.5	0.54	502.63	135.63	$ 156,287,000
53.5	0.68	968.06	182.71	$ 195,506,030
54	0.79	1242.9	223.9	$ 218,070,840
55	0.95	1806.59	346.72	$ 260,274,820
56	1.16	2511.28	543.32	$ 341,147,630
57	1.39	3433.53	848.76	$ 469,069,220
57.5	1.53	4031.43	1034.89	$ 547,479,020
58	1.89	5629.59	1270.6	$ 725,039,110
58.5	2.01	6000.86	1377.07	$ 769,035,800
61.5	2.24	7131.37	1744.89	$ 874,623,240
Maximums	**2.26**	**7220**	**1778**	**$ 885,878,120**

The purpose of the LST is to evaluate risk to life and property; hence its purpose is to capture potential consequences rather than estimating damages. Thus, it does not provide a depth damage curve which is critical to estimating expected annual damages or EAD.

Damages are typically estimated based on the relationship between the depth of inundation, which is the difference between the estimated Water Surface Elevation (WSE) and the First Floor Elevation (FFE), and the percentage of damage to the structure based on that inundation depth and the depreciated replacement value of the structure. Both FEMA and the Corps of Engineers rely on depth percent damage tables that have been developed from statistical analysis and expert opinion elicitation studies from decades of flooding experience. FEMA has a curve for a consolidated or generic building that is a composite of commercial and residential structures. Table 2 consolidates and shows estimates of damage to structures grouped by ground elevations for an event approximating the maximum with project level of protection internal to the Dykstra Levee.

Table 2 Estimated maximum inundation depths and damages for Dykstra structures by ground elevation groups

Approx Ground Elevation	Value of Structures by Ground Elevation Groups	WSE (Dykstra Segment Minimum)	Average Depth (feet)	Average First Floor Elevation	Average Structure Inundation Depth	FEMA Depth % Damage for Consolidated Buildings	Estimated Damage to Structures
40	0	61.2	21.2	2	19.2	50%	$ -
52.5	$156,287,000	61.2	8.7	2	6.7	42%	$ 65,449,870
53.5	$ 39,219,030	61.2	7.7	2	5.7	37%	$ 14,562,810
54	$ 22,564,810	61.2	7.2	2	5.2	33%	$ 7,367,862
55	$ 42,203,980	61.2	6.2	2	4.2	30%	$ 12,612,237
56	$ 80,872,810	61.2	5.2	2	3.2	28%	$ 22,728,495
57	$127,921,590	61.2	4.2	2	2.2	25%	$ 32,359,045
57.5	$ 78,409,800	61.2	3.7	2	1.7	22%	$ 17,392,862
58	$177,560,090	61.2	3.2	2	1.2	18%	$ 31,964,367
58.5	$ 43,996,690	61.2	2.7	2	0.7	17%	$ 7,325,889
61.5	$105,587,440	61.2	-0.3	2	-2.3	0%	$ -
				Total Estimated Damage to Structures			**$ 211,763,437**

The table shows that a 200-year event would be expected to cause over $200M in damages to the $885M in property internal to the leveed area.

If repairs are made (the with-project condition), the levee will be restored to a 200-year level of protection. However, the levee is not designed to provide protection from events that exceed a 200- year event; thus any events that exceed in severity a .005 exceedance probability event would result in more severe consequences. Those consequences will not be estimated, but truncated at the maximum WO Project estimate.

Since the LST does not provide estimates of inundation depths at more frequent events that would be expected to breach the levee in the without project condition an assumption is made that the damage curve is a linearly increasing function with higher damages associated with lower probability events. The area under the curve of this function is the sum of the expected value of all events between the zero damage event (.5 annual exceedance probability) and the design Level Of Protection or the 200- year event. This sum is considered a reasonable approximation of is the EAD that will be prevented in the with project or rehabilitated condition. For a detailed explanation of the procedure used to calculate EAD see IWR88-R-2 IWR Urban Flood Damage Manual; Page V55. Table 4 shows the results of applying that process to calculate the With and Without Project EAD, rounded to the nearest $1,000.

The comparison of the without-project and with-project damages is presented in Table 3 below.

Table 3 Comparison of Without-Project and With-Project Damages - Project Annual Benefits

EAD W/O Rehab	$104,622,000
EAD W/ Rehab (Truncated)	$318,000
Rehab Benefits	**$104,304,000**

Project Costs:

The Total Project Cost estimate is $1,905,900. This cost is converted to annual costs by amortizing it over the project lifetime of 50 years at the current federal interest rate of 3.5%, then adding the annual estimated O&M cost of $2,000Table 4 Annualized Costs displays the summary of the annual costs.

Table 4 Annual Costs

Total Project Cost	**$**	**1,905,900**
Principle and Interest (50 yrs @ 3.5%)	$	81,300
O&M	$	2,000
Total Annual Cost	**$**	**83,300**

Summarized Financial and Economic Data: Displayed in Table 5

Table 5 Summarized Financial and Economic Data (rounded)

Construction Cost	$	1,550,000
S&A	$	93,000
Contingency (10%)	$	155,000
Total Construction Cost	$	1,798,000
Engineering and Desion (6%)	$	108,000
Total Project Cost	**$**	**1,906,000**
Federal Project Cost (80% construction cost + E&D)	$	1,546,000
Sponsor Project Cost (20% construction cost)	$	360,000
Project Annual Costs (50 years @ 3.5%)	$	83,000
Project annual Beneifts	$	104,304,000
Benefit-Cost Ratio		**1,257**

Benefit/Cost Ratio: The Benefit Cost Ratio, BCR is $104,304,000/$83,300 (rounded to $1,000's) or 1257..

c. Benefit Checks: Benefit checks are summarized in Table 6.

Table 6 Checks

Check	Check Met?
Property value $886M First costs: $1,906,000	Yes
Crop benefits per acre do not exceed 5% of land value per acre	Not applicable
Crop benefits do not exceed net crop income	Not applicable
Each property owner accounts for less than 25% of the benefits	Yes

This project is economically justified

13. Environmental.

a. General: There are 3 project locations along the Dykstra levee. The most upstream site includes a slumped area, largely covered by blackberries. Eight alders (approximately 6 to 14 inch DBH) and one willow thicket exist in the project site that may need to be removed for the construction. The opposite bank is the North Green River Park, with a largely forested bank and a small shallow beach river access point.

The middle site includes scattered trees and is predominatly covered by blackberry and reed canarygrass with a few rose and snowberry. Two large Douglas fir trees (approximately 18 to 20 inch DBH), a plum tree, an ornamental maple sapling, a willow thicket and a large multistemmed cedar (five stems, each about 10 inches DBH) may need to be removed to complete the repair. This site is opposite the only natural off-channel habitat in the lower Green River. The in-channel vegetated island provides important fish and wildlife habitat in this reach.

The final site is located near Dykstra Park. This site is a grass lined slope. Runoff from the roof of adjacent homes is piped over to the levee slope in the project area and a very large four-foot outfall is located at the downstream end of the project site. The outfall's concrete apron is undermined. If this is to act as a tie-in location, the undermining will need to be addressed. This could include construction of a small coffer dam and use of concrete. The opposite bank is Isaac Evans Park and is a forested bank.

All three sites included armoring prior to the damaging event. Also at all three sites the landward side of the levee has been filled so that the elevation is now even with the levee crown. The backside of the levee is a residential area with well maintained lawns, ornamental plantings, and scattered trees.

The Green River contains spawning populations of fall Chinook, coho, pink, and fall chum salmon, and winter and summer steelhead. Small numbers of sockeye salmon are also found. Bull trout use the lower river for feeding and rearing. The project area has documented Chinook, chum, sockeye, pink, and steelhead spawning, as well as coho rearing.

b. Endangered Species Act: The following species listed under the Endangered Species Act as endangered (E) or threatened (T) and their designated critical habitat (CH) or proposed critical habitat (PCH) could occur within the project area vicinity**.**

1. Coastal/Puget Sound Bull Trout (*Salvelinus confluentus*) (T) (CH)
2. Puget Sound Chinook (*Oncorhynchus tshawytscha*) (T) (CH)
3. Puget Sound Steelhead (*O. mykiss*) (T) (PCH)
4. Marbled Murrlet (*Brachyramphus marmoratus*) (T)

Any potential effects of the proposed work on threatened and endangered species and designated critical habitat will be addressed in separate compliance documentation in accordance with Section 7 of the Endangered Species Act.

The removal of trees could result in a decrease in shading to the river. This can have two impacts, including decreased protection from artificial lighting and solar radiation.

The work window for this location is 1 August to 31 August. This window misses the most sensitive periods for fish. Impacts to fish would be mitigated by the following: 1) any in-water work associated with repairs and rehabilitation of the levee would occur during the fisheries work window; 2) use of clean fill material; 3) minimizing tree loss to the extent possible, and 3) following Best Management Practices. It is anticipated that mitigation will be required for the removal of trees and the proposed in-water work.

c. Environmental Considerations During Construction:

-Water Quality: Short-term, discountable adverse impacts may result from the repairs to the levee. A temporary increase in turbidity due to fill placement may occur. Turbidity will be monitored during construction. If turbidity exceeds water quality standards, construction will recommence when turbidity returns to acceptable levels. The removal of trees could result in a decrease in shading to the river which could have a minor impact on water quality by decreasing nutrient input and shading. The loss of shading could contribute to increased water temperatures. The use of concrete at or below the waterline would be done using best management practice to limit the potential for water quality impacts.

-Fish and Wildlife: When completed, this levee repair is not intended or expected to generate appreciable change in habitat conditions as compared with pre-existing conditions. Repair construction work may cause indirect impacts to fish and wildlife. There may be a temporary increase in turbidity due to rock placement or in-water work. Working during the work window will limit this impact on fish.

Short-term impacts to wildlife could occur from levee repair construction activities. Noise from construction activities may temporarily disturb and displace birds and mammals that occur within and adjacent to the project area. Animals in this urban area are expected to be tolerant of human presence and would be expected to use

nearby areas if displaced during construction, and would be expected to return soon after construction was completed.

Care will be taken during design and construction to ensure that there is no increased energy directed at the opposite bank. This is especially important at the site opposite the instream island which provides important habitat for the lower Green River.

-Wetlands: A wetland biologist will survey the sites, particularly the site near Dykstra Park. The riverward bench at the upstream end of the site, where the repair is likely to tie in requires a survey to ensure impacts are avoided or minimized.

d. Cultural Resources: The Corps completed a records search and literature review of information on file at the Washington State Department of Archaeology and Historic Preservation. The review indicated that there are no known archaeological resources in the project's area of potential effects (defined as the zone directly affected by the levee restoration), and no historic era structures eligible for listing on the National Register for Historic Places (NRHP).

Prior to approval of the proposed project , the Corps would conduct a cultural resources survey of the project area to determine whether there are historic properties within the area of potential effect and whether there is a potential for the proposed project to cause effects to historic properties that may be located in or adjacent to the project area. The Corps would also consult with the Muckleshoot Indian Tribe to determine if there are properties of religious or cultural significance that might be affected. The results of the cultural resources investigation and the Corps' findings of effect on historic properties would be submitted to the Washington State Historic Preservation Office (SHPO) and the Muckleshoot Indian Tribe for their review and comment. Should the project have an adverse effect on a historic property, the adverse would be resolved prior to project approval in accordance with the regulations implementing Section 106of the National Historic Preservation Act (NHPA).

e. Recreation: All three Dykstra repair sites are not accessible to the public and are not available for general recreation. Two of the sites however are adjacent to and/or opposite public parks. Access to the downstream site will likely occur through Dykstra Park. Dykstra Park would be impacted during construction by the presence of machines, increased noise, and partial closure for safety. The parks on the opposite side of the river could also be impacted by the presence of machines and increased noise. No permanent impact to recreation is expected.

f. Cumulative Effects: No other projects are known for these areas. A full cumulative effects analysis will be completed during the NEPA process in E&D.

g. Coordination: The proposed work is formally coordinated throughout the planning, design, and construction phases with the following tribes and agencies:

(1) U.S. Fish and Wildlife Service
(2) National Marine Fisheries Service
(3) U.S. Fish and Wildlife Service
(4) Muckleshoot Indian Tribe
(5) State Historic Preservation Office
(6) Washington Department of Ecology
(7) King County

Recommendations from the above listed agencies will be considered and implemented as appropriate. Any suggested revisions to the design as a result of agency review will require design, cost, and technical review prior to construction. Environmental effects of the proposed levee rehabilitation will be considered during the planning process in accordance with ER 200-2-2, Procedures for Implementing NEPA, paragraph 8, Emergency Actions.

h. Further Compliance: An environmental assessment (EA) will be prepared to evaluate probable impacts of the project on the existing environment. Factors addressed by the evaluation include, but are not limited to: public safety, water quality, wetlands, threatened and endangered species, noise, economics, fish, and wildlife. The EA will be coordinated with applicable Federal and State resource agencies and tribes. The NEPA process will be concluded as pursuant to requirements in ER 200-2-2. In addition, the requirements for compliance with the Endangered Species Act will be completed.

Pursuant to 33 U.S. Code section 1344(f)(l)(B), emergency reconstruction of recently damaged parts of levees does not require a Clean Water Act Section 404 evaluation provided that the work is conducted for maintenance purposes. Analogizing to the Code of Federal Regulations Title 33, Section 323.4(a)(2), the rehabilitation may be exempted from requirements of Section 404, provided the rehabilitation does not include any modifications that change the character, scope, or size of the original fill design. Concerning scope and size, the proposed repair would not require a Section 404(b)(1) evaluation as long as the footprint of the levee repair, which falls within waters of the U.S., is no larger than the pre-damage footprint and wetlands are not temporarily impacted during construction. However, if Section 404 jurisdiction is triggered, a 401 water quality certification might be required.

A Coastal Consistency Determination will be completed prior to construction and will be coordinated with the State Department of Ecology.

i. Environmental Enhancement Features: Project construction may include environmental enhancement features to offset temporary construction impacts. Environmental features proposed by agencies will be fully engineered and reviewed during E&D. Per guidance from Corps Headquarters, 5% of construction cost may be used for environmental features. Likely mitigation could include onsite or offsite plantings.

14. Interagency Levee Task Force (ILTF)

HQUSACE has not directed activation of an ILTF for the flood event associated with the March 2014 floods in Western Washington. However, informal coordination with FEMA is ongoing.

15. Project Management

a. Funding Authority:

(1) Program and Appropriation: Public Law 84 – 99, Levee Rehabilitation, Flood Control and Coastal Emergencies

(2) Project Funding Class: 320

(3) Project CWIS Number: 146620

b. Project Funds

Construction Subtotal	$ 1,550,000
S&A (6%)	$ 93,000
Contingency (10%)	$ 155,000
Total Construction Cost	$ 1,798,000
Engineering & Design (6% Federal)	$ 108,000
Total Project Costs	**$ 1,906,000**
Federal Project Costs (80% Construction Cost + E&D)	$ 1,546,000
Sponsor Project Costs (20% Construction Cost)	$ 360,000
Project Estimated Annual Benefits	$ 104,304,000
B/C Ratio	**1,257 : 1**

c. Project Repair Schedule

The Work Window (work allowed in the water) is 1-31 August. Work performed outside this window will only consist of work that is not in the water.

RESPONSIBLE PARTY	MILESTONE TAKS	MILESTONE DATE
COE	PIR Approval	15 August 2014
COE	E&D complete	31 October 2014
COE	LOA and LER Cert Documents to Non-federal Sponsor, and Designs for Review NLT	5 December 2014
King County	Sign LOA by Non-federal Sponsor	15 January 2015
COE	Environmental Documentation	15 January 2015
King County	Non-federal Sponsor certifies lands	13 February 2015
King County	Non-federal Sponsor provides cash contribution	13 March 2015
COE	RE Division Certifies Lands Available	27 March 2015
COE	Solicit contractors	10 April 2015
COE	Initiate construction	1 August 2015
COE	Complete construction	31August 2015

d. Project Authentication

Prepared by: CPT Rex Broderick, (206) 316-3133
Emergency Management approval by: Doug Weber, (206) 764-3406

e. Technical Points of Contact

Emergency Management: Doug Weber, (206) 764-3406
Project Manager: CPT Rex Broderick, (206) 316-3133
Economics: Don Bisbee, (206) 764-3713
Environmental: Bobbi Jo Mcclain, (206) 764-6968
Cultural Resources: Ashley Dailide, (206) 764-6942
Geotechnical Engineering: Seth Klein, (206) 316-3949
Civil Engineering: Michael Peele, (206) 764-6961
Program Management: Cathie Desjardin, (206) 764-3452
Real Estate: Diane Jordan, (206) 316-4419
Hydraulics and Hydrology: Brendan Comport, (206) 764-3565

Appendix A: Project Sponsor's request for Rehabilitation Assistance.

King County

Water and Land Resources Division
Department of Natural Resources and Parks
King Street Center
201 South Jackson Street, Suite 600
Seattle, WA 98104-3855
206-477-4800 Fax 206-296-0192
TTY Relay: 711

April 16, 2014

Doug Weber
Chief, Emergency Management Branch
Seattle District, Corps of Engineers
4735 East Marginal Way South
Seattle, WA 98134

Dear Mr. Weber:

Pursuant to your March 17, 2014, notice to levee sponsors, I am writing to request rehabilitation assistance for flood-damaged levees under the authority of Public Law 84-99. Specifically, I request assistance with the following damages to King County levees that were identified after flood conditions receded in March 2014:

1. Desimone levee on the right bank of the Green River in the City of Tukwila, River Mile (RM) 14.5-14.6, between Cascade Avenue South and the West Valley Highway (SR 181). Slumping of the riverward levee slope has undermined its rock armor and exposed its subgrade materials.

2. Segale levee on the left bank of the Green River in the City of Tukwila, RM 15.1, between Riverside Drive and Todd Boulevard South (if both were extended). Steep fill slope at an access ramp transition is slumping.

3. Holiday Kennel levee on the right bank of the Green River in the City of Kent, RM 18.5-18.7, between South 218th Street and South 221st Street (if both were extended). Slumping of the riverward levee slope has undermined its rock armor and exposed its subgrade materials.

4. Russell Upper levee on the right bank of the Green River in the City of Kent, RM 19.4-19.9, between South 232nd Street and South 237th Street (if both were extended). Slumping of the riverward levee slope has undermined its rock armor and exposed its subgrade materials.

5. Signature Pointe levee on the right bank of the Green River in the City of Kent, RM 23.0, roughly where 66th Avenue South would intersect the river. Slumping of the riverward levee slope has exposed subgrade materials.

6. Nursing Home levee on the right bank of the Green River in the City of Kent, RM 25.9, roughly where South 262nd Street would intersect the river. Rill erosion of the riverward levee slope.

7. Dykstra levee on the left bank of the Green River in the City of Auburn, RM 29.7, roughly where Pike Street Northeast would intersect the river. Slumping of the riverward levee slope has undermined its rock armor and exposed its subgrade materials.

8. Dykstra levee on the left bank of the Green River in the City of Auburn, RM 30.2-30.3, roughly where 19th Drive Northeast would intersect the river. Slumping of the riverward levee slope has undermined its rock armor and exposed its subgrade materials.

These levees were damaged in the flooding of March 2014. Each of these damaged levees is currently eligible for rehabilitation assistance. All are maintained by King County on behalf of the King County Flood Control District.

I should mention that the Segale levee (#2 above) is part of the Tukwila 205 federal levee for which the City of Tukwila serves as local sponsor. We partner with the city in maintenance of the Segale levee.

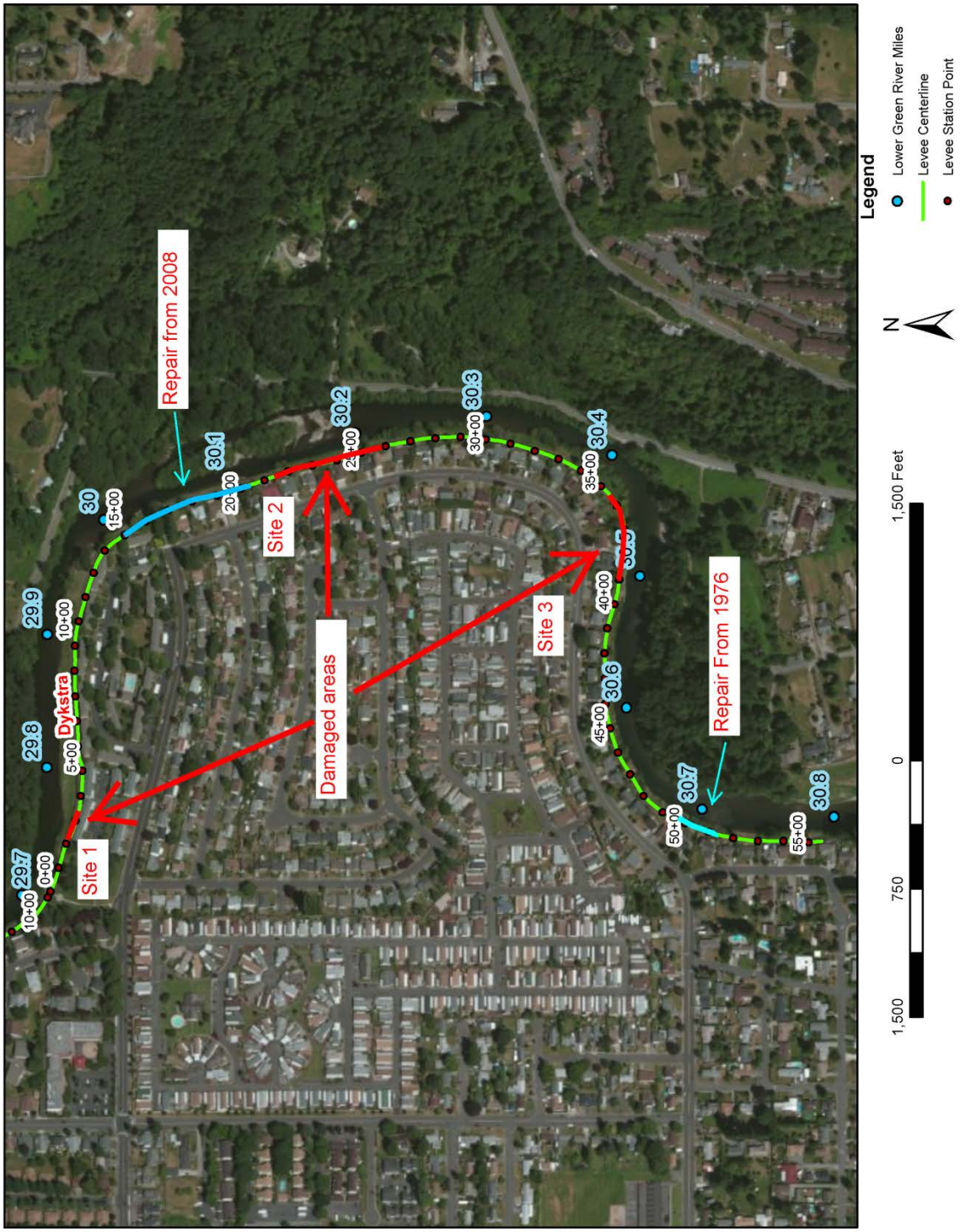
I should also mention that the Nursing Home levee (#6 above) is part of the Horseshoe Bend 205 federal levee, for which the King County Flood Control District is the local sponsor.

I have directed Tom Bean to serve as our point of contact for this work. He can be reached by telephone at 206-477-4638 and by email at tom.bean@kingcounty.gov. Please work with Mr. Bean to achieve rehabilitation of these damaged levees.

Sincerely,

Steve Bleifuhs, Manager
River and Floodplain Management Section

cc: Bob Giberson, Director of Public Works, City of Tukwila
Tim LaPorte, Public Works Director, City of Kent
Kevin Snyder, Community Development and Public Works Director, City of Auburn
Lorin Reinelt, Green River Basin Supervising Engineer, King County River and Floodplain Management Section (RFMS)
Tom Bean, Special Projects Engineer, RFMS



Appendix B: Project location vicinity, maps, and drawings.
Figure B-1: Site map with proposed and past repair sites.

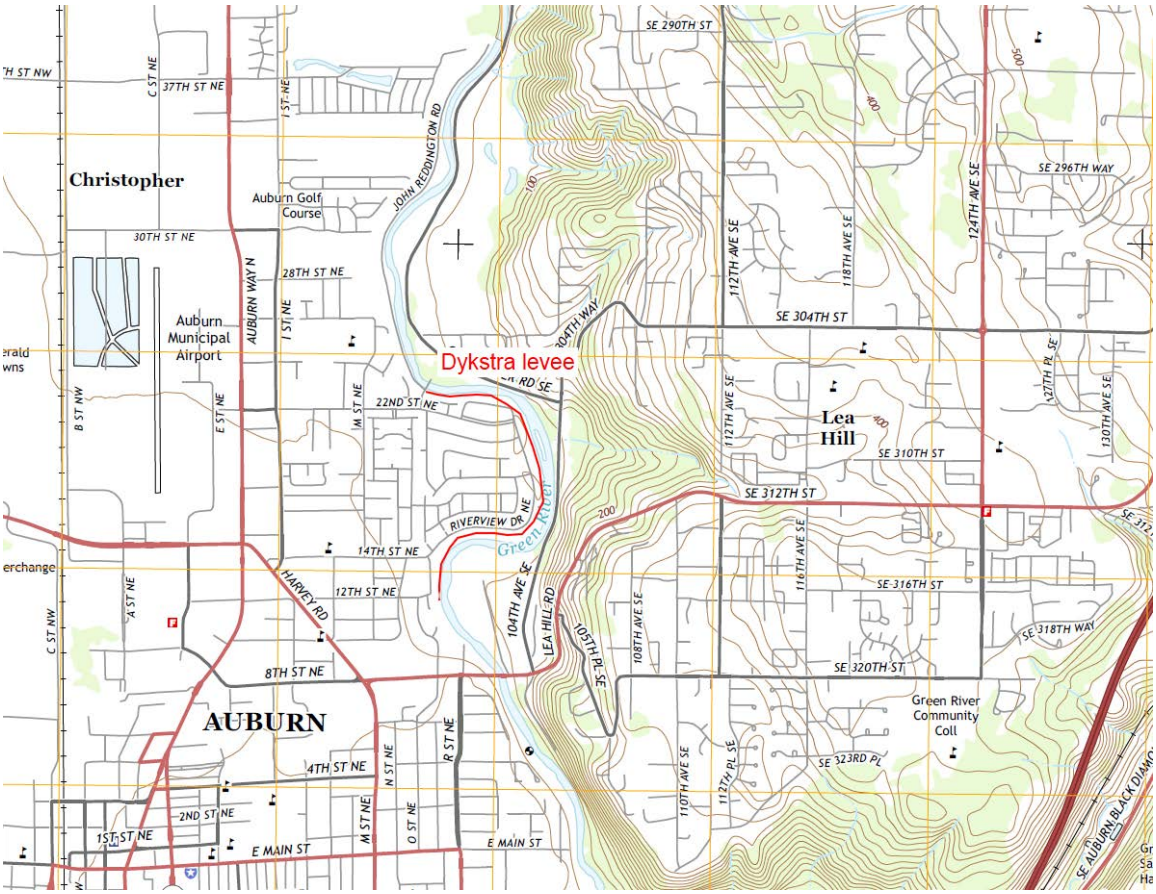


Figure B-2: Project location

Figure B-3: Project site plan 1

Figure B-4: Project site plan 2

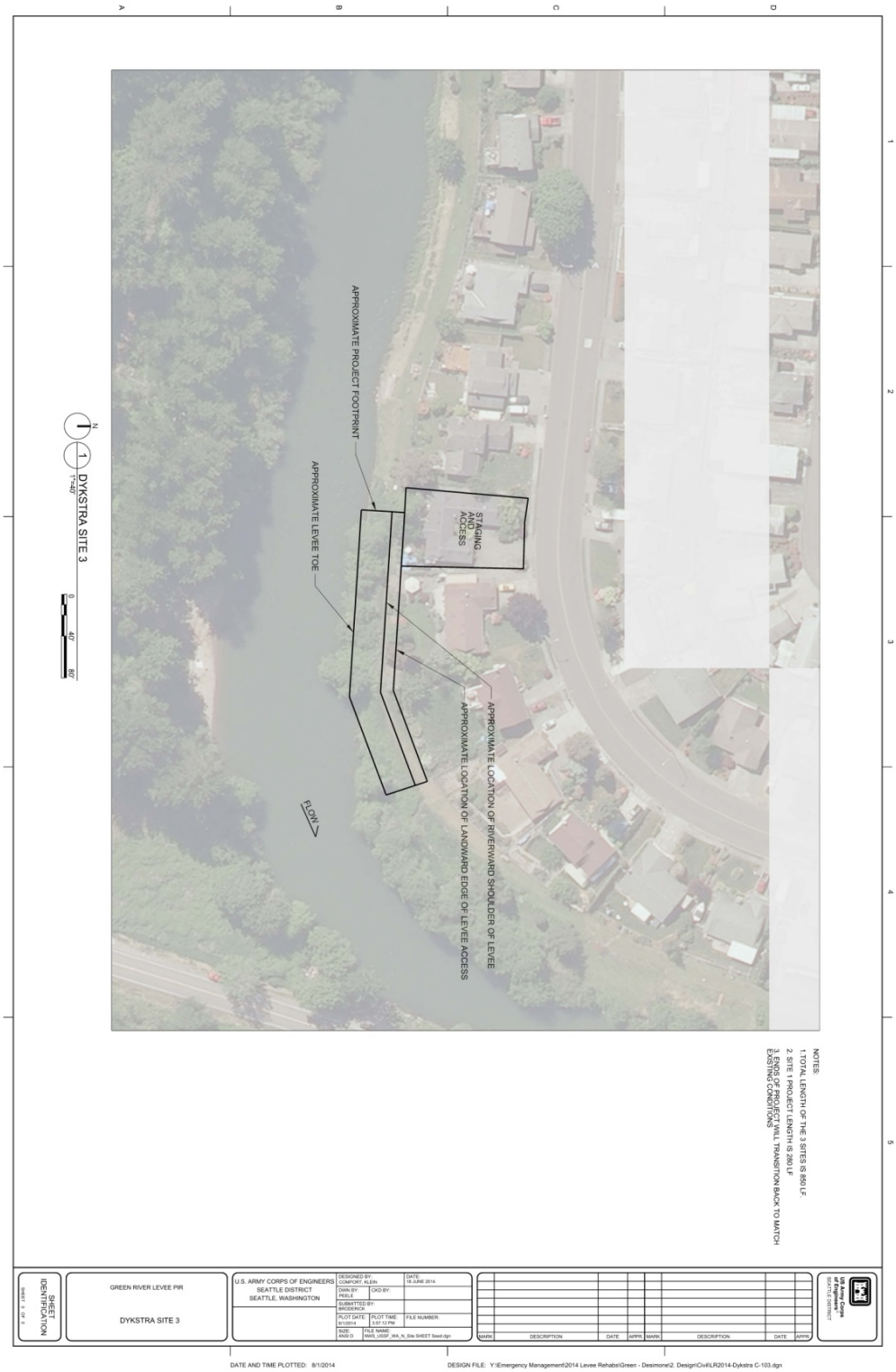


Figure B-5: Project site plan 3.
Note: Staging area is now an empty lot, the house is no longer there.

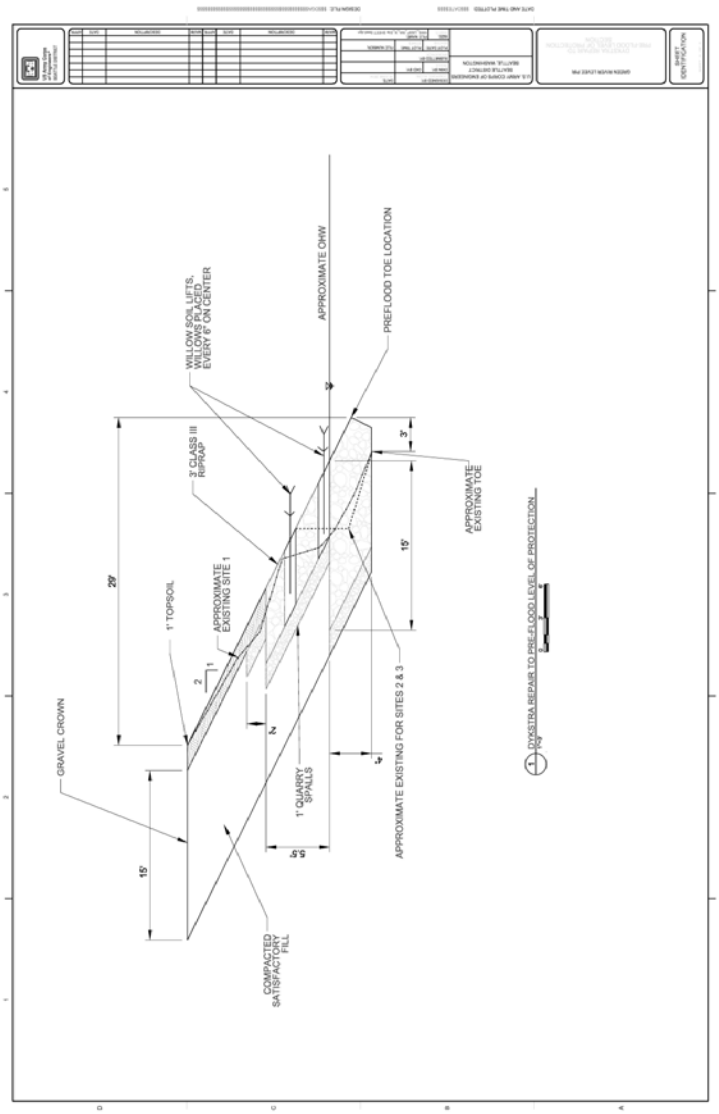


Figure B-6: Dykstra Typical repair section.

Appendix C: Photos of damaged area

Photo C-1: Damaged portion near downstream end of levee (site 1). Station ~2+50 - Looking upstream. (Corps photo).

Photo C-2: Damaged section looking downstream (site 1). Station ~2+50 (Corps photo)

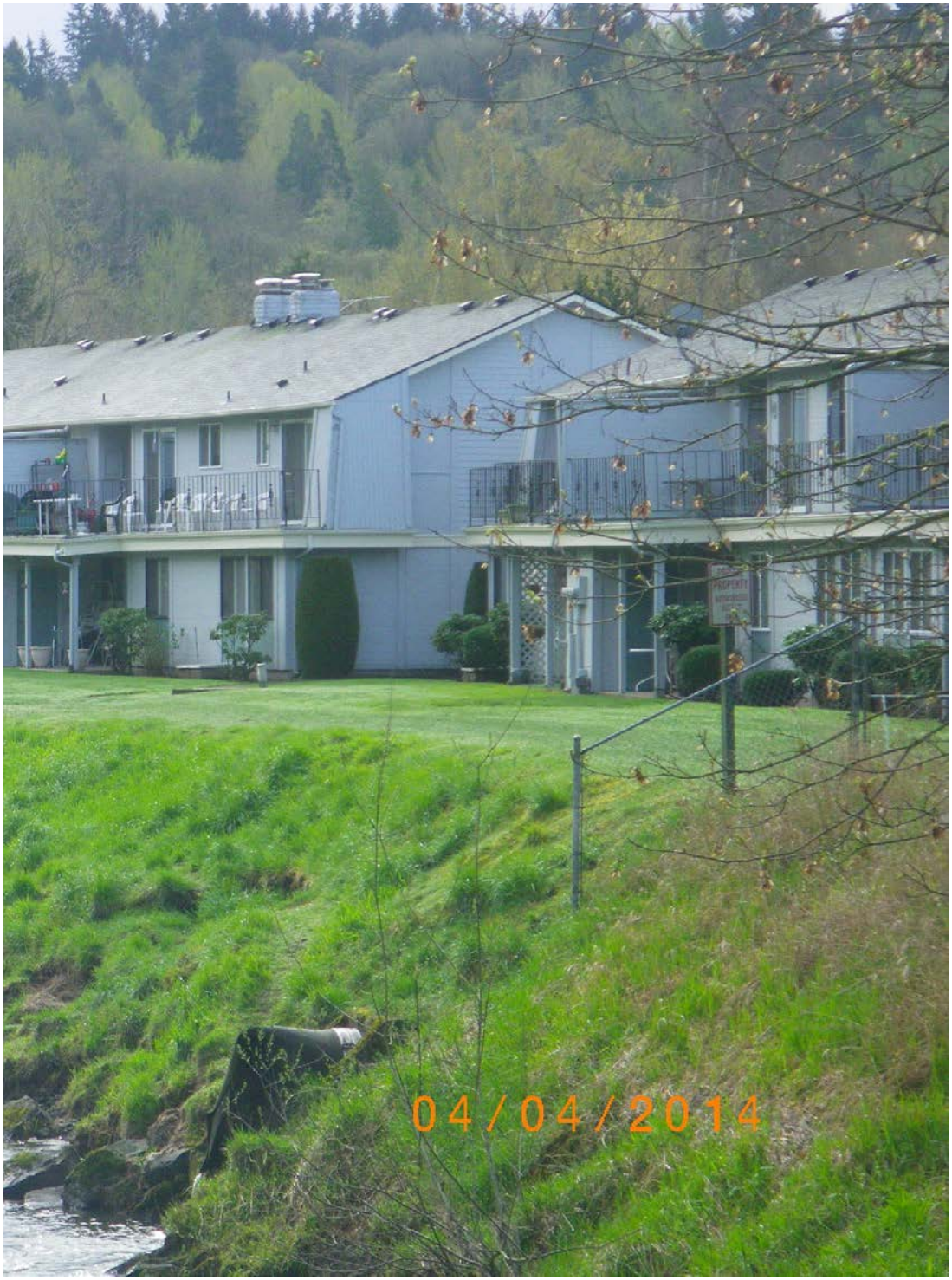


Photo C-3: 42" CMP culvert that will need to be partly replaced during the repair to site 1. Looking upstream

Photo C-4: Close up of culvert from Photo C-3, approximate Station 2+00.

Appendix Z: PIR Review Checklist

Dykstra Levee Repair
PIR Review Checklist for Repair of FCW Rehabilitation Projects

	YES	NO	N/A	
1.	__X__	____		The project is active in the RIP. [ER, 5-2.a..]
2.	__X__	____		The project was damaged by flood(s) or coastal storm(s). [ER, 5-2]
3.	_ X ___	____		The Public Sponsor has requested Rehabilitation Assistance in writing. [ER, 5-10.b.]
4.	__ X __	____		The public sponsor has agreed to sign the Cooperation Agreement, which will occur before USACE beings rehabilitation work. [ER, 5-10.]
5.	__X__	____		The estimated construction cost of the rehabilitation is greater than $15,000, and is not considered sponsor maintenance. [ER, 5-2.q.]
6.	__X__	____		The repair option selected is the option that is the least cost to the Federal government, or, the sponsor's preferred alternative is selected with all increases in cost paid by the public sponsor. PIR includes justification for non-selection of the least cost alternative. [ER, 5-2.h. and 5-11.e.(3)]
7.	__X__	_____		The public sponsor is aware of the opportunity to seek a nonstructural alternative project, and has decided to proceed with a structural rehabilitation. [ER, 5-16.]
8.	__X__	____	____	The cost estimate in the PIR itemized the work to identify the Public Sponsor's cost share. [ER, 5-11.]
9.	__X__	____		The rehabilitation project has a favorable benefit cost ratio of greater than 1.0:1. [ER, 5-2.r.]
10.	_X___	____		The proposed work will not modify FCW to increase the degree of protection or capacity, or to provide protection to a larger area. [ER, 5-2.n.]
11.	____	____	__X__	Betterments are paid 100 percent by the Public Sponsor [ER 5-2.o.]
12.	__X__	____	_____	The CA contains a provision for 80% Federal and 20% local cost share for non-Federal projects [ER, 5-11.a.]
13.	____	____	__X___	Cost for any betterments are identified separately in the cost estimate. [ER, 5-2.o.]

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Dykstra PIR Review Checklist for FCW Rehabilitation Projects (Continued)

	YES	NO	N/A	
14.	____	____	__X__	Repair of deliberate levee cuts is the responsibility of the public sponsor, except as provided for in ER 500-1-1, paragraphs 5-2.j. and 4-3.h. [ER, 5-2.j. and 4-3.h.]
15.	__X__	____		All deficient and deferred maintenance will be paid for or accomplished by the Public Sponsor, without receiving credit toward any sponsor's cost share. [ER, 5-2.g.]
16.	____	____	__X__	Any relocation of levees is adequately justified. [ER, 5-2.h.]
17.	__X__	____		USACE assistance does not correct design or construction deficiencies. [ER, 5-12.a.]
18.	__X__	____		An assessment of environmental requirements was completed. [ER, 5-13., and EP, Figure 5-3, paragraph 12.]
19.	__X__	____		The project complies with NEPA, and required documentation was completed and placed in Appendix G of the PIR. [ER, 2-3.k.; ER, 5-13.; and EP, Figure 5-3, paragraph 12.]
20.	__X__	____		The Endangered Species Act was appropriately considered. [ER, 5-13.g., and EP, Figure 5-3., paragraph 12.]
21.	__X__	____		EO 11988 requirements were considered in the process of evaluating the proposed project for rehabilitation. [ER, 5-13.f., and EP, Figure 5-3, paragraph 12.]
22.	__X__	____		The completed PIR has been reviewed and the PIR Checklist has been reviewed and signed by the Emergency Management Office. [EP, 5-11.a.(3)(a)]
23.	__X__	____	____	The completed PIR meets all policy, procedural, content, and formatting requirements of ER 500-1-1 and EP 500-1-1. [ER, 2-3.b.]

EM REVIEWING OFFICIAL'S SIGNATURE

P.E.

NAME

TITLE CIVIL ENGINEER

TELEPHONE NUMBER 206-764-3452

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