Feasibility Study
Cedar Street On-Ramp to I-93 South

September 2019

Prepared for:

City of Woburn

Prepared by:

Stantec Consulting Services Inc.

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Sign-off Sheet

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Feasibility Study Cedar Street On-Ramp to I-93 South

Table of Contents

Executive Summary

1.0 Introduction

2.0 Existing Conditions

3.0 Design Constraints

4.0 Proposed Ramp Alignment and Geometrics

5.0 Land Use and Environmental Impacts

6.0 Conclusion

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Executive Summary

Stantec Consulting Services Inc. was retained by the City of Woburn to perform a feasibility study and merge analysis for alternative slip ramp configurations from Cedar Street in Woburn to I-93 South and to assess operational and design criteria characteristics. Initially, two alternative slip ramp configurations were developed. The first ramp configuration (Condition 1) consisted of a new slip ramp and merge with the existing southwest, outer connection on-ramp to I-93 south from I-95 north, resulting in a two lane on-ramp to I-93 south. The second ramp configuration (Condition 2) consisted of a separate, single lane on-ramp from Cedar Street to I-93 south, resulting in successive on-ramps in advance of the Salem Street Bridge over I-93 south.

Early on in the Study it became clear that only one configuration could adequately satisfy both of the design parameters noted in the opening statement above. The geometric analysis for Condition 1 showed the profile for the proposed Cedar Street slip ramp could not join the existing southwest, outer connection on-ramp to I-93 until approximately the location of the existing ramp nose to I-93 south. In order to develop a standard two-lane entrance ramp (parallel type) to I-93 south, the location of the existing on-ramp had to shift westerly toward Kelly Nissan of Woburn. This shift created sharper ramp curvature resulting in a substandard design speed for the proposed Cedar Street on-ramp and significant impacts to adjacent land uses which would require property takings and major reconfiguration of the Kelly Nissan of Woburn parking lot and internal circulation roads. Additionally, the resulting parallel type, two-lane entrance ramp configuration along I-93 southbound would impact the existing Salem Street Bridge Overpass of I-93 south. Consequently, further analysis of Condition 1 was abandoned in favor of Condition 2.

The geometry of Condition 2, although not in full conformance with every FHWA design parameter for highway ramps, is most likely acceptable due to lower operating speeds at the ramp terminal near Cedar Street. While the horizontal geometry configuration meets minimum FHWA criteria for curvature and compound curve ratio for 25 MPH, the minimum lengths of these horizontal curves are slightly less than minimum requirements. Based on our assessment of the overall Condition 2 ramp geometry, and the fact that all other FHWA design parameters for successive, single lane, parallel type ramps are met, we find the geometry of Condition 2 to be acceptable given the existing site constraints and low design speed at the ramp terminal area in the vicinity of Cedar Street. Further refinement of this geometry may be possibly during final design development to minimize or eliminate any adverse impacts relating to specific geometric deficiencies. A complete summary of geometric characteristics for Condition 2 are discussed in more detail in Chapter 4 Proposed Ramp Alignment and Geometrics.

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1.0 INTRODUCTION

Stantec Consulting Services Inc. has provided the City of Woburn with professional engineering assistance in assessing whether a slip ramp from Cedar Street in Woburn to I-93 southbound can meet FHWA design criteria, in accordance with the Study goals and objectives established by the City of Woburn and identified below:

Stantec analyzed the following two conditions operationally and geometrically:

Condition 1 – A new, parallel type, two-lane entrance ramp (one lane from Cedar Street plus one lane from the existing outer ramp connection from I-95 northbound) onto I-93 southbound. Ramp geometry, merge and weave areas, acceleration lane requirements and tapers for a parallel type, two-lane entrance ramp onto I-93 southbound were assessed.

Condition 2 – Successive, one lane entrance ramps (the existing outer ramp connection from I-95 northbound followed by a new, single lane ramp connection from Cedar Street) onto I-93 south. Ramp geometry, merge and weave areas, acceleration lane requirements and tapers for successive, one lane entrance ramps onto I-93 southbound were assessed.

The following sections document, in detail, our conceptual engineering efforts related to this feasibility study of a new Cedar Street on-ramp to I-93 southbound. Our report outlines the existing conditions, identifies design constraints, discusses ramp operations and geometric characteristics and describes the land use and environmental impacts associated with a proposed Cedar Street on-ramp to I-93 southbound.

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2.0 EXISTING CONDITIONS

Cedar Street in Woburn is a two-way, local street that provides direct access to a number of multi-unit residential complexes, office/retail establishments and light industrial uses along its corridor which runs from Salem Street west of Washington Street to a cul-de-sac in the vicinity of Kelly Nissan of Woburn, located immediately adjacent to the southwest outer ramp connection from I-95 northbound to I-93 southbound. The intersection of Cedar Street and Washington Street is signalized. A cul-de-sac and driveway connections, located at the end of Cedar Street, provide turnaround ability and local access to adjacent land uses. These uses include a storage parking lot for Kelly Nissan immediately east of Cedar Street and Rivals/Ironwood Batting Cages (92-98 Cummings Park Drive) west of Cedar Street.

The municipal boundaries of the City of Woburn and the towns of Reading and Stoneham come together within the existing I-93/I-95 interchange, just south of the southwest outer ramp from I-95 northbound to I-93 southbound. This area is where the proposed Cedar Street on-ramp originates. Along the proposed route commercial offices, and light industrial and warehouse uses line the westerly side while existing I-93 southbound is immediately located to the east.

There are three distinct bordering vegetated wetlands that occupy the area. One is located between the existing southwest outer ramp connection from I-95 northbound to I-93 southbound and the aforementioned storage parking lot for Kelly Nissan. Earlier highway improvements involving ramp re-alignments at the interchange and widening of shoulders resulted in new drainage infrastructure and a 6-foot-wide ditch adjacent to the existing outer ramp connection. These drainage improvements convey natural stream flows from the southeast quadrant of the interchange and the existing highway system to the southwest quadrant of the interchange. Over the years this ditch has evolved into a larger wetland resource area.

Another wetland area, slightly smaller, is located between two existing storage parking lots surrounding the Kelly Nissan buildings. An 18-inch outfall servicing natural stormwater flows from the southeast quadrant of the interchange and a 12-inch outfall servicing the existing highway system covey stormwater flows toward this wetland. Both outfalls terminate in a combined headwall at this wetland resource area.

A third, larger bordering vegetated wetland stretches from Admiral Metals at 11 Forbes Road, Woburn to the cul-de-sac at Lynn Street bordered by I-93 southbound on the east and Admiral Metals Servicecenter Company on the west. This wetland resource area collects stormwater flows via an 18-inch outfall servicing natural stormwater flows east of I-93 northbound in Stoneham and Woburn and a 12-inch outfall servicing the existing highway system. Both outfalls terminate in a combined headwall at this wetland resource area.

In addition to these wetland resource areas existing conditions along the proposed alignment of the Cedar Street on-ramp include features typically found within an interstate highway layout including drainage outfalls, headwalls, ditches, swales, side slopes, ledge outcrops, guard rail, mile markers and sign structures. Also, along I-93 southbound just behind guard rail protection, there is a small, one story building located approximately 400 feet north of the Salem Street Bridge overpass of I-93. Upon further investigation this building apparently contains traffic counting equipment to monitor daily and peak hour operations along Interstate I-93.

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3.0 DESIGN CONSTRAINTS

At the start of this feasibility study Stantec engineers visited the project site and documented various design constraints based on our field reconnaissance along Cedar Street as well as past study reports for the I-93/I-95 Interchange and earlier construction plans for I-93. For the most part, our site visit confirmed conditions along Cedar Street and the I-93 southbound corridor have changed very little since the I-93/I-95 Interchange Transportation Study was completed in 2007. Except for the installation of a small, one story building containing traffic counting equipment located immediately adjacent to I-93 southbound and just north of the Salem Street Bridge as well as an additional access drive to Rivals/Ironwood Batting Cages (92-98 Cummings Park Drive) on the west side of Cedar Street, the project area is predominantly constrained by I-93 southbound on the east and office/retail or light industrial uses on the west adjacent to the I-93 Interstate layout line.

Other primary physical constraints include several wetland resource areas, existing highway or ramp embankment areas together with accompanying drainage facilities (i.e., outfalls, headwalls, ditches, etc.), sign structures and some ledge outcrops. All of these constraints are typically found within a highway corridor.

Based on our traffic assessment of a proposed Cedar Street one lane vs two lane on-ramp configuration onto I-93 southbound, Stantec highway and traffic engineers recommend successive one lane entrance ramps. The justification for this recommendation is described in more detail in Chapter 4 Proposed Ramp Alignment and Geometric Characteristics. Nevertheless, regardless of configuration, the critical design constraints include the following:

- Existing Cedar Street
- Existing I-93/I-95 southwest outer connection ramp
- Existing I-93 southbound
- Kelly Nissan of Woburn
- Interstate I-93 Highway Layout
- Existing Salem Street Bridge Overpass

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4.0 PROPOSED RAMP ALIGNMENT AND GEOMETRICS

Stantec engineers examined two possible ramp configurations for their traffic operational and geometric characteristics. These configurations included the following two conditions:

Condition 1 (Two-lane Parallel Type Entrance) – A new two-lane on ramp (one lane from Cedar Street and one lane from the existing outer ramp connection from I-95 northbound) to I-93 southbound.

Condition 2 (Successive One-lane Parallel Type Entrance Ramps) – Successive, one lane ramps (the existing outer ramp connection from I-95 northbound to I-93 southbound followed by a new, single lane ramp connection from Cedar Street).

There are some key traffic benefits and operational advantages for the Condition 2 configuration in both the existing and future build scenarios.

Condition 2 is more consistent with the configuration of other ramp terminals along the I-93 corridor. All of the entrance ramps along I-93 are single lane on-ramps, the majority of which are parallel type design. This type of continuity and consistency provides drivers with a sense of expectation when entering a highway system. The principle of route continuity simplifies the driving task in that it reduces lane changes, simplifies signing, delineates the through route and reduces the driver's search for directional signing. Condition 2 provides all of these operational benefits and does so in a more efficient manner consistent with the rest of the regional highway network. Condition 2 allows a substantial volume of traffic to enter Interstate I-93 south in a diverse manner and in a more orderly flow that will minimize congestion and potential slowdown of mainline speeds. This is particularly important when through travel lanes are near or at capacity.

In Condition 1 traffic in the right ramp lane of the two lane on-ramp that is destined for points further south than Montvale Avenue is required to make multiple lane changes. Even traffic in the left ramp lane must complete a lane change to continue south. These lane changes coupled with the amount of exiting traffic from I-93 south to Montvale Avenue result in multiple weaves causing severe mainline congestion and traffic slowdowns between interchanges.

Additionally, the Condition 1 configuration is not as compatible as the Condition 2 configuration with future plans for the interchange as defined in the I-93/I-95 Interchange Transportation Study completed in 2007 for the Massachusetts Executive Office of Transportation Office of Transportation Planning. In that study, each recommended alternative included a grade separated connection from I-95 south to I-93 south, eliminating the existing northwest loop ramp in the I-93/I-95 cloverleaf interchange and its associated weaves. The proposed Cedar Street on-ramp in Condition 2 occupies much of the same space and exhibits the same geometric characteristics as this grade separated connection once it meets existing ground. Consequently, should the recommendations from the 2007 I-93/I-95 Interchange Transportation Study be carried forward and implemented in the future, much of the proposed Cedar Street on-ramp can be salvaged and used as part of that larger interchange solution.

The key objective of this feasibility study, as discussed with City of Woburn officials, was to determine if a slip ramp from Cedar Street onto I-93 southbound could meet FHWA design criteria. Ramp geometry, merge and weave areas, acceleration lane lengths and taper requirements were assessed for each of the above-mentioned conditions. However, fairly early during our study it was evident only one configuration could adequately satisfy entrance ramp design criteria as defined by FHWA and MassDOT while achieving acceptable traffic operations and geometric characteristics.

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The geometry for Condition 1 was essentially controlled by the profile for a new slip ramp connection. Stantec engineers discovered the proposed Cedar Street on-ramp profile could not join the existing southwest, outer connection on-ramp to I-93 from I-95 northbound until approximately the location of the existing ramp nose to I-93 south. As a result, to develop a standard two-lane entrance ramp to I-93 south, the location of this connection had to shift southwesterly toward Kelly Nissan of Woburn. This was necessary in order to develop a two-lane entrance ramp consistent with FHWA criteria for parallel type, entrance ramps. The parallel configuration is recommended here in lieu of the taper type design since other ramp terminals within the I-93/I-95 Interchange use the parallel type design; thus, drivers are accustomed to that type of entrance. Unfortunately, the shift to the southwest created sharper ramp curvature resulting in a substandard design speed for the proposed Cedar Street on-ramp and significant impacts to adjacent land uses that require property takings and a major reconfiguration of the Kelly Nissan of Woburn parking lot and its internal circulation road network.

The alignment for Condition 1 also results in an extended entrance ramp configuration requiring an adequate distance of 800 to 1,000 feet to fully develop a single, two-lane entrance ramp before joining the four I-93 southbound mainline lanes. Desirably, on-ramp travel speeds should be about 80% of the mainline travel speeds at the entrance gore. These two lanes continue south as a parallel type, two lane entrance onto I-93 for a distance of approximately 2,000-2,500 feet to allow sufficient time and distance for vehicles in the left ramp lane to move into the I-93 southbound mainline lanes. This opens space and provides time for vehicles in the right ramp lane to move into the left ramp lane, particularly for those vehicles destined for points south of the Montvale Avenue exit ramp. Where the right ramp lane terminates, this left ramp lane actually becomes a 5th auxiliary lane on I-93 south, so vehicles destined for points further south would need to shift lanes. A 300-foot minimum taper is required to terminate the right ramp lane.

Overall, from beginning to end along I-93 south, the entire desirable length of the proposed two-lane on-ramp configuration is approximately 3,800 feet. The distance from where the two single lane ramps first join each other to the Salem Street Bridge Overpass is about 3,000 feet, therefore, this two-lane configuration extends well beyond this bridge, most likely requiring the bridge to be reconstructed. As a result, further analysis of Condition 1 was abandoned in favor of Condition 2.

The geometry of Condition 2 follows FHWA design criteria for successive, parallel type, single lane entrance ramps. While the horizontal geometry at the ramp entrance from Cedar Street may not be fully compliant with every FHWA design parameter for highway ramps, is most likely acceptable due to lower operating speeds at the ramp terminal near Cedar Street itself. It is solely within this terminal area that not all geometric design criteria have been met based on the conceptual layout we have developed for the proposed Cedar Street on ramp.

Desirably, the minimum horizontal central curve and transition curve radii must be 144 feet and 216 feet, respectively, using a desirable 1.5 to 1.0 compound curve ratio and a 25 MPH design speed for the ramp terminal area. The proposed horizontal alignment for Condition 2 includes a 186-foot radius central curve and 338-foot radii entering and exiting transition curves. The resulting compound curve ratio is 1.8 to 1.0. These design values meet FHWA design criteria for the given design speed.

While the horizontal geometry configuration meets minimum criteria for curvature and compound curve ratio for 25 MPH, the minimum lengths of these horizontal curves fall a bit short. For a 25 MPH design, the horizontal central curve and transition curve lengths must be 375 feet and 200 feet, respectively. For Condition 2, the horizontal central curve length is 277 feet and the transition curve lengths range from 150

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feet to 160 feet. However, it is important to mention this particular design parameter is not considered one of the more critical elements in design and often requires adjustment to conform to existing site constraints when designing within an existing facility. Based on our assessment of the Condition 2 ramp terminal geometry it is our opinion that further refinement of this geometry may be possibly during final design development. Nevertheless, it would seem the Condition 2 geometry would be acceptable given that most of the required design criteria is met except for the lengths of curve. These curve lengths can be optimized during later stages of design, but they must also be sensitive to existing site constraints and other controlling features (i.e., right of way, adjacent land uses, etc.).

In regard to the configuration of successive single lane, parallel type, entrance ramps, FHWA criteria has been met. The existing southwest outer connection ramp from I-95 northbound to I-93 southbound remains in its current location with its current ramp nose location. The acceleration lane of this on-ramp was lengthened about 900 feet a few years ago to help ease congestion on the mainline and provide more space and time for vehicles on the ramp to move left into the mainline lanes. This extended acceleration lane is maintained in the Condition 2 configuration. At about 1,200 feet north of the Salem Street Bridge overpass of I-93 south, traffic from this existing on-ramp has completely merged onto the I-93 southbound mainline and a right-side shoulder is developed on I-93. The length of this first on-ramp from its physical ramp nose on I-93 south to the end of its acceleration lane taper is approximately 1,600 feet.

Continuing south, the physical ramp nose of the second on-ramp, the proposed Cedar Street on-ramp, is located approximately 500-600 feet south of where the acceleration lane taper for the first on-ramp terminates. Four mainline lanes of traffic exist along this stretch of I-93 southbound. The distance between successive ramp noses along I-93 south is approximately 2,200 feet which far exceeds the minimum FHWA design requirements for successive, single lane, parallel type, entrance ramps. The entrance gore for the proposed Cedar Street on-ramp extends approximately 500 feet in length before this single lane on ramp transitions to an auxiliary lane from the Salem Street Bridge overpass of I-93 to the next exit ramp at Montvale Avenue in Stoneham. This auxiliary lane configuration is very similar to the existing configuration along I-93 northbound between Montvale Avenue and I-95 (Route 128).

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5.0 LAND USE AND ENVIRONEMTAL IMPACTS

Land use impacts of the proposed Cedar Street on-ramp are predominantly confined to the existing I-93 Interstate Layout and the areas immediately adjacent to I-93 southbound. In each of the two configurations studied significant portions of the proposed ramp connections run parallel to I-93 southbound mainline lanes.

As described earlier in this report, the ramp terminal area in Condition 1 does not meet FHWA minimum design criteria for 25 MPH and requires both significant property takings and a reconfiguration of the storage parking lot and internal circulation roads at Kelly Nissan of Woburn. For this reason, and because of its inferior operational characteristics and impact to the Salem Street Bridge overpass, Stantec engineers abandoned further analysis of this configuration in favor of Condition 2 which involves successive, single lane, parallel type, entrance ramps onto I-93 south. Therefore, the remainder of this section will focus primarily on the land use and environmental impacts associated with Condition 2.

Near the proposed on-ramp terminal in the vicinity of the existing Cedar Street cul-de-sac, the access drives to Kelly Nissan of Woburn on the east and Rivals/Ironwood Batting Cages (92-98 Cummings Park Drive) on the west must be closed to develop a ramp terminal with No Access side lines. The actual on-ramp terminal is located just beyond the first access drive to Kelly Nissan of Woburn which is situated on Cedar Street at the southerly property line. The proposed on-ramp starts out at a 30-foot width and immediately tapers to a 22-foot width at the first transition curve as the ramp begins to reverse direction and continues easterly up a 1.8% to 2.4% profile grade to meet existing elevations along I-93 south.

As the proposed on-ramp curves to the east its alignment impacts a portion (approximately 4,000 sf) of private property owned by Kelly Nissan of Woburn. This is a necessary property taking that does not impact the number of parking spaces but does require a narrowing of the northern most parking lot aisle due to the closure of the cul-de-sac access drive and widening of the remaining access drive. This remaining access drive is widened to a 30-foot width to accommodate two-way access and the pavement marking layout within the parking lot is shifted uniformly about 6 feet northerly to accommodate the same number of parking stalls. Approximately 12 light pole locations within the parking lot will need to be modified accordingly.

As the on-ramp continues easterly then southerly to meet existing elevations along I-93 south the ramp alignment directly impacts a wetland resource area located between Kelly Nissan of Woburn and the existing southwest outer ramp connection from I-95 northbound. This area has evolved into a wetland resource from its original construction as a 6-foot wide drainage ditch at the base of the existing highway ramp embankment. It is likely this segment of the proposed Cedar Street on-ramp will be constructed on embankment as well, thus, a retaining wall is required to minimize wetland impacts and avoid further impact to Kelly Nissan of Woburn along its northeastern property line. Depending on permitting requirements, and in addition to other wetland mitigation measures, a possible bridge structure may be needed to span a portion of this wetland area. Existing drainage facilities impacted by the ramp alignment include 12-inch and 18-inch RCP outfalls with flared ends and an 18-inch ACCMP metal end outfall, all of which would need to be extended into the wetland area.

The proposed Cedar Street on-ramp continues south and adjacent to the extended acceleration lane of the existing southwest outer ramp connection to I-93 south. The proposed ramp alignment impacts a second wetland resource area adjacent to I-93 south just north of BJs Wholesale parking lot. Drainage facilities impacted include 12-inch and 18-inch RCP outfalls with flared ends. Both of these outfalls would likely need

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to be extended into the wetland area. Depending on permitting requirements, and in addition to other wetland mitigation measures, a possible wall structure could be installed to minimize impacts.

The proposed on-ramp alignment continues south and immediately parallel to the existing acceleration lane along I-93 south. It is anticipated both facilities will be separated by double-faced guard rail. From the wetland resource area noted above to a point behind the Shore Educational Collaborative building (10 Forbes Road) additional drainage facilities will be required to service the new on-ramp. Stormwater flows are expected to be conveyed toward the I-93 median via the existing closed system in this area.

Between the Admiral Metals building (11 Forbes Road) and I-93 south, a third wetland resource area is impacted by the on-ramp alignment. Roadway embankment necessary to support the ramp impacts this wetland area which is fed by a 60-inch RCP that conveys overland stormwater flows from Stoneham, east of I-93, and an 18-inch RCP that services the highway system. Both of these existing pipes outfall through a combined headwall and into the wetland area. The pipes would need to be extended and a new headwall installed to accommodate the proposed on-ramp. Again, depending on permitting requirements, and in addition to other wetland mitigation measures, a possible wall structure could be installed parallel to the wetland to minimize impacts.

As the proposed Cedar Street on-ramp joins I-93 south the final 1,000 feet of on-ramp impacts a number of existing infrastructure components. These elements include a 4-foot wide drainage ditch at the toe of slope, 6-inch and 8-inch sub-drain under the mainline shoulder, directional and informational signs, and a small, one story building that contains traffic counting equipment at the ramp gore area where the one lane ramp transitions to an auxiliary lane along I-93 south. Additional drainage structures and pipes will be required to service the new on-ramp along this stretch of highway. Stormwater flows are expected to be conveyed toward the I-93 median via the existing closed system. Design plans for a possible future noise barrier in this area to mitigate highway noise that might affect Woburn residences along Lynn Street and Stephanie Circle have been on hold for several years but should be coordinated with the Cedar Street on-ramp, if implemented.

The on-ramp auxiliary lane, which essentially starts at the Salem Street Bridge overpass, occupies the existing I-93 southbound right-side shoulder and continues south to the exit ramp at Montvale Avenue in Stoneham. Using the existing shoulder as an auxiliary lane is similar to what was done on I-93 north a number of years ago between Montvale Avenue and the I-93/I-95 Interchange. No impacts are anticipated south of the Salem Street Bridge.

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6.0 CONCLUSION

In summary, based upon our findings documented in this Feasibility Study Report Stantec engineers have determined Condition 2, successive, one-lane entrance ramps, is the preferred option to meet FHWA design criteria while achieving acceptable traffic operations. Notwithstanding environmental and permitting issues, the resulting ramp alignment meets FHWA design criteria with the exception of one design element, length of horizontal curve. Since these “less than desirable” lengths occur in the vicinity of the ramp terminal near Cedar Street where speeds are much lower, we believe this is not a significant disadvantage. In developed, populated suburban areas this design element is often unattainable due to existing site constraints. Overall, the Condition 2 configuration satisfactorily addresses capacity, route continuity, weaving, signing, cost concerns, right of way impacts and constructability.

We have documented our findings and, although we have determined a proposed on-ramp connection from Cedar Street to I-93 south is geometrically feasible and meets FHWA design criteria, there are a significant number of unresolved issues which still need to be addressed. These consist of the following design process and environmental challenges including, but not necessarily limited to, the following:

1. FHWA/MassDOT position on this connection from Cedar Street (early coordination meeting recommended)
2. Long Range Transportation Plan considerations (introduction to Boston MPO)
3. TIP Process (PNF, PIF, PRC approval)
4. Wetland Impacts and Probable Need for a Variance (lengthy process)
5. Environmental Assessment and Environmental Impact Report process (costly schedule delays)
6. Requirement for an Interchange Modification Report (FHWA/MassDOT requirement)
7. 25% Design, Functional Design Report, Design Exception Report, etc.,

To adequately address the design process and environmental issues noted above Stantec engineers reached out to MassDOT officials to obtain some preliminary feedback. As a result of those discussions, a number of critical items were identified. The list of items above reflect just some of the steps in the process which need to be discussed and addressed with regulatory agencies prior to proceeding with any further design development relating to this proposed ramp connection.

Having stated such, Stantec suggests a meeting should be arranged between FHWA, MassDOT District 4 and City officials to discuss a proposed on-ramp from Cedar Street to I-93 south in more detail before the City pursues further design development of this connection. At a minimum, City officials and regulatory agencies should discuss the specific requirements associated with a number of the items noted above before proceeding.

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APPENDIX A

Concept Study Drawings

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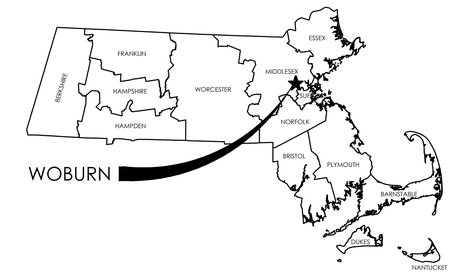

LOCATION MAP

WOBURN, MA

CEDAR STREET ON-RAMP FEASIBILITY STUDY

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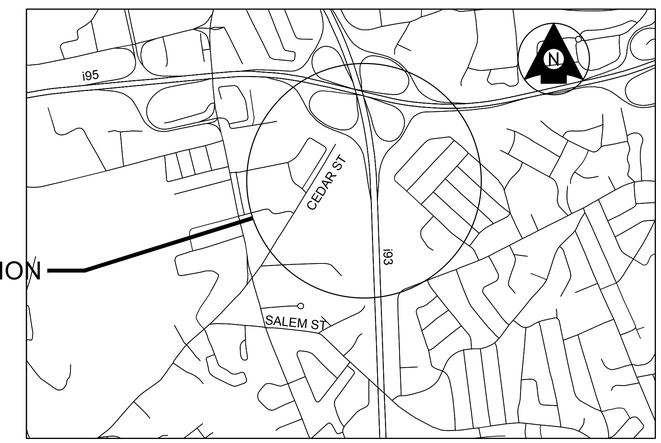


VICINITY MAP
1" = 2500'

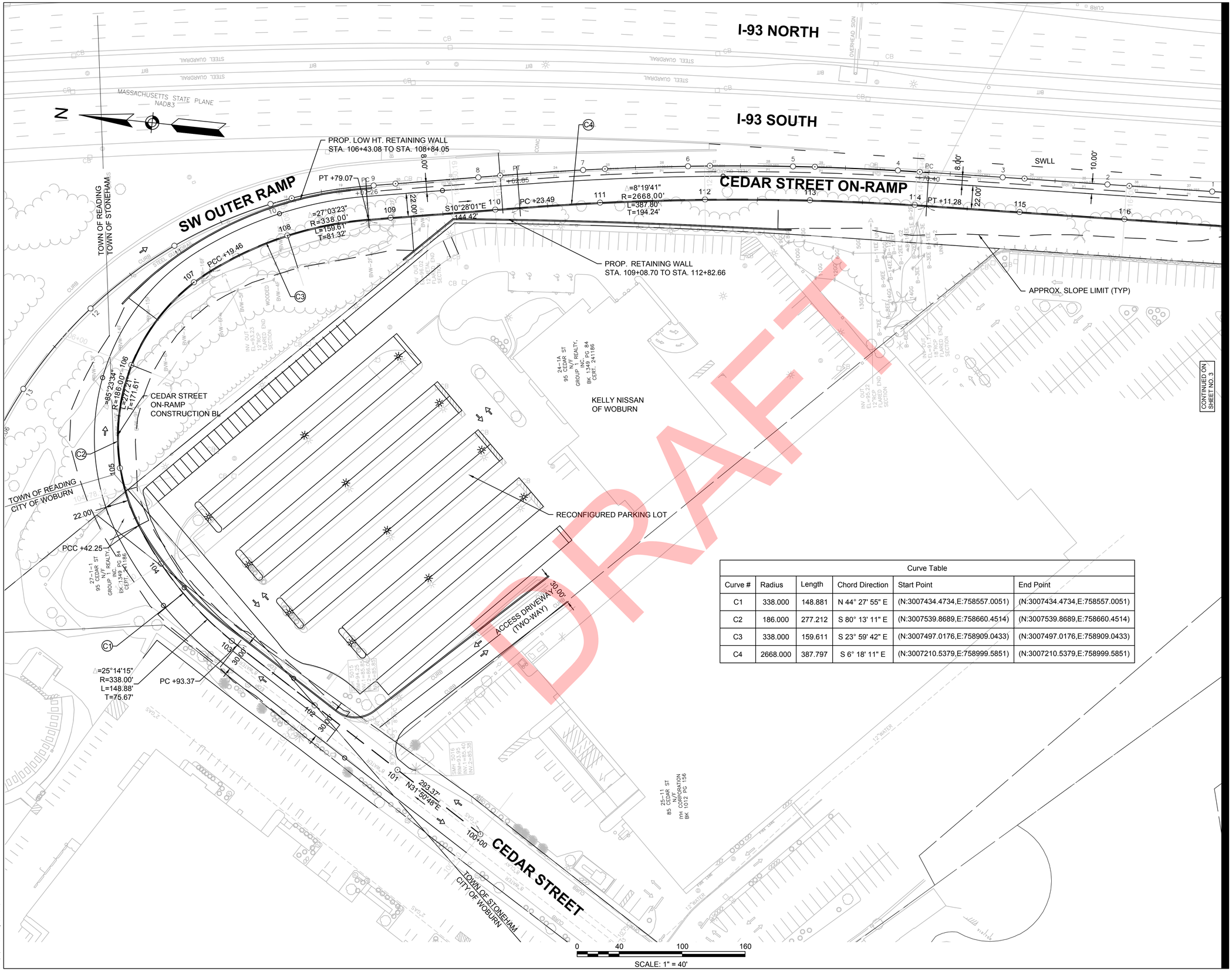
SHEET NO.	DESCRIPTION
1	TITLE SHEET AND INDEX
2 - 5	CONSTRUCTION PLANS
6 - 7	PROFILES
8 - 18	CROSS-SECTIONS

THE MASSACHUSETTS DEPARTMENT OF TRANSPORTATION HIGHWAY DIVISION STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES DATED 1988, AS AMENDED, THE ENGLISH SUPPLEMENTAL SPECIFICATIONS DATED JULY 1, 2015, THE 2014 CONSTRUCTION STANDARD DETAILS, THE 1996 CONSTRUCTION AND TRAFFIC STANDARD DETAILS (AS RELATES TO TRAFFIC STANDARD DETAILS ONLY), THE 2009 MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS WITH MASSACHUSETTS AMENDMENTS, THE 1990 STANDARD DRAWINGS FOR TRAFFIC SIGNALS AND HIGHWAY LIGHTING AND THE LATEST EDITION OF THE AMERICAN STANDARD FOR NURSERY STOCK WILL GOVERN.

PROJECT NUMBER: 179410749

FEASIBILITY STUDY

ORIGINAL SHEET - ARCH D



Curve Table					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C1	338.000	148.881	N 44° 27' 55" E	(N:3007434.4734,E:758557.0051)	(N:3007434.4734,E:758557.0051)
C2	186.000	277.212	S 80° 13' 11" E	(N:3007539.8689,E:758660.4514)	(N:3007539.8689,E:758660.4514)
C3	338.000	159.611	S 23° 59' 42" E	(N:3007497.0176,E:758909.0433)	(N:3007497.0176,E:758909.0433)
C4	2668.000	387.797	S 6° 18' 11" E	(N:3007210.5379,E:758999.5851)	(N:3007210.5379,E:758999.5851)

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2019/02/21 2:33 PM By: Casalino, Luciana

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Legend

Notes

Revision | By | Appd. | YY.MM.DD

Issued | By | Appd. | YY.MM.DD

File Name: | Dwn. | Chkd. | Dsgn. | YY.MM.DD

Permit-Seal

Client/Project
CITY OF WOBURN

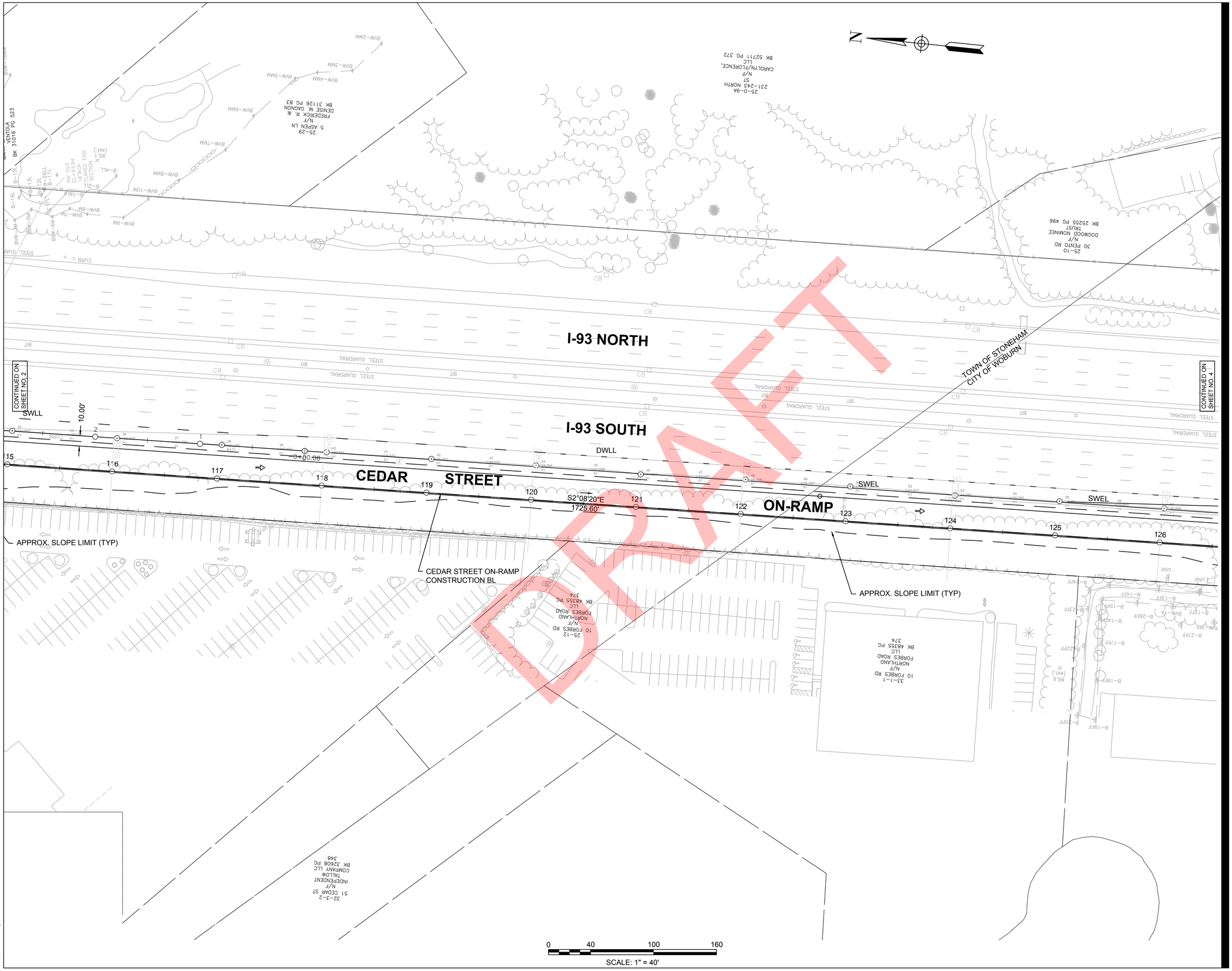
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CONSTRUCTION PLAN
PART 1 OF 4

Project No. 179410749 | Scale

Drawing No. | Sheet | Revision



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Client/Project

CITY OF WOBURN

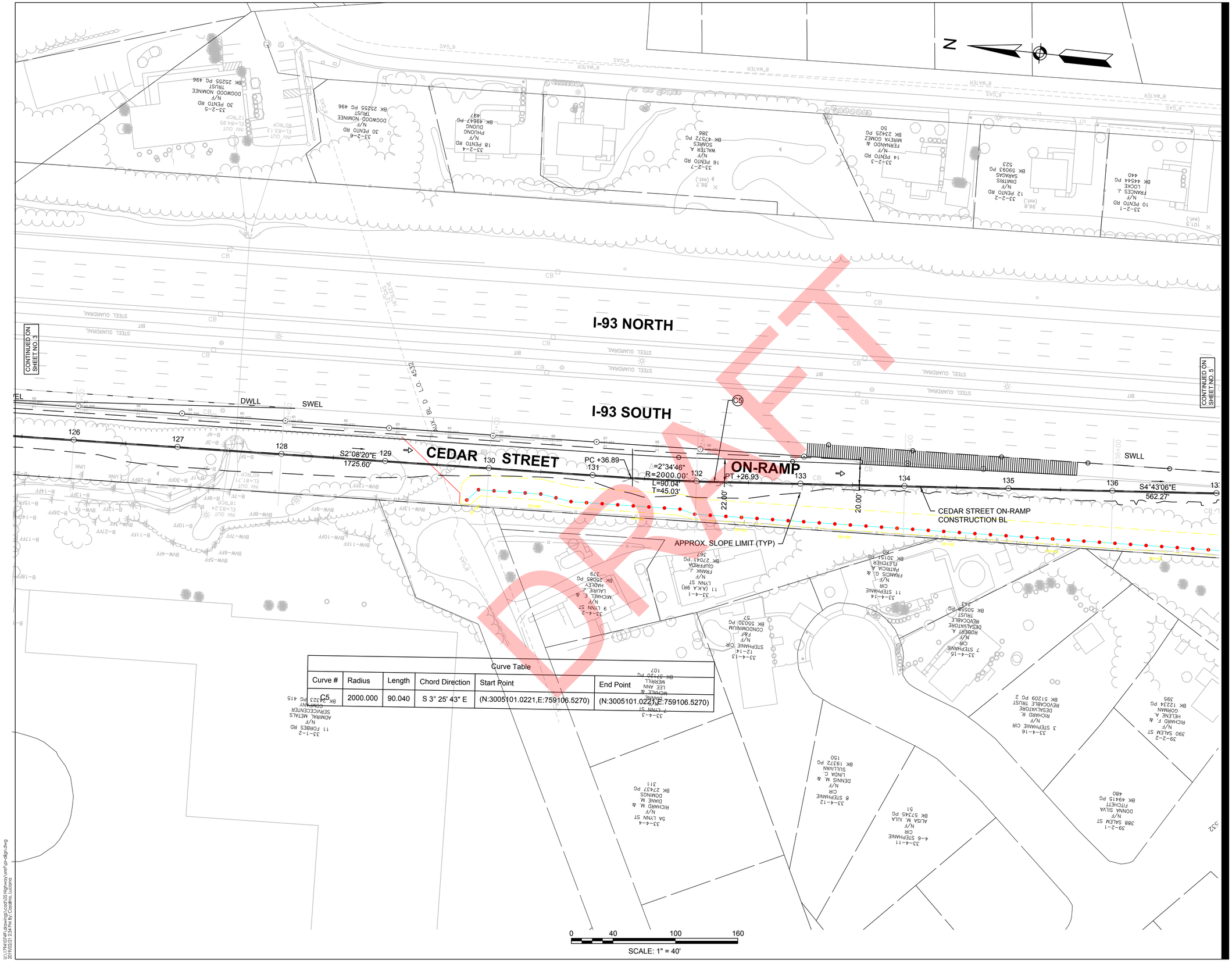
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title

CONSTRUCTION PLAN
PART 2 OF 4

Project No.	Scale	
179410749		
Drawing No.	Sheet	Revision



Curve Table					
Curve #	Radius	Length	Chord Direction	Start Point	End Point
C5	2000.000	90.040	S 3° 25' 43" E	(N:3005101.0221,E:759106.5270)	(N:3005101.0221,E:759106.5270)

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	Dwn.	Chkd.	Dsgn.	YY.MM.DD

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Client/Project

CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title

CONSTRUCTION PLAN
PART 3 OF 4

Project No. 179410749

Scale

Drawing No.

Sheet

Revision

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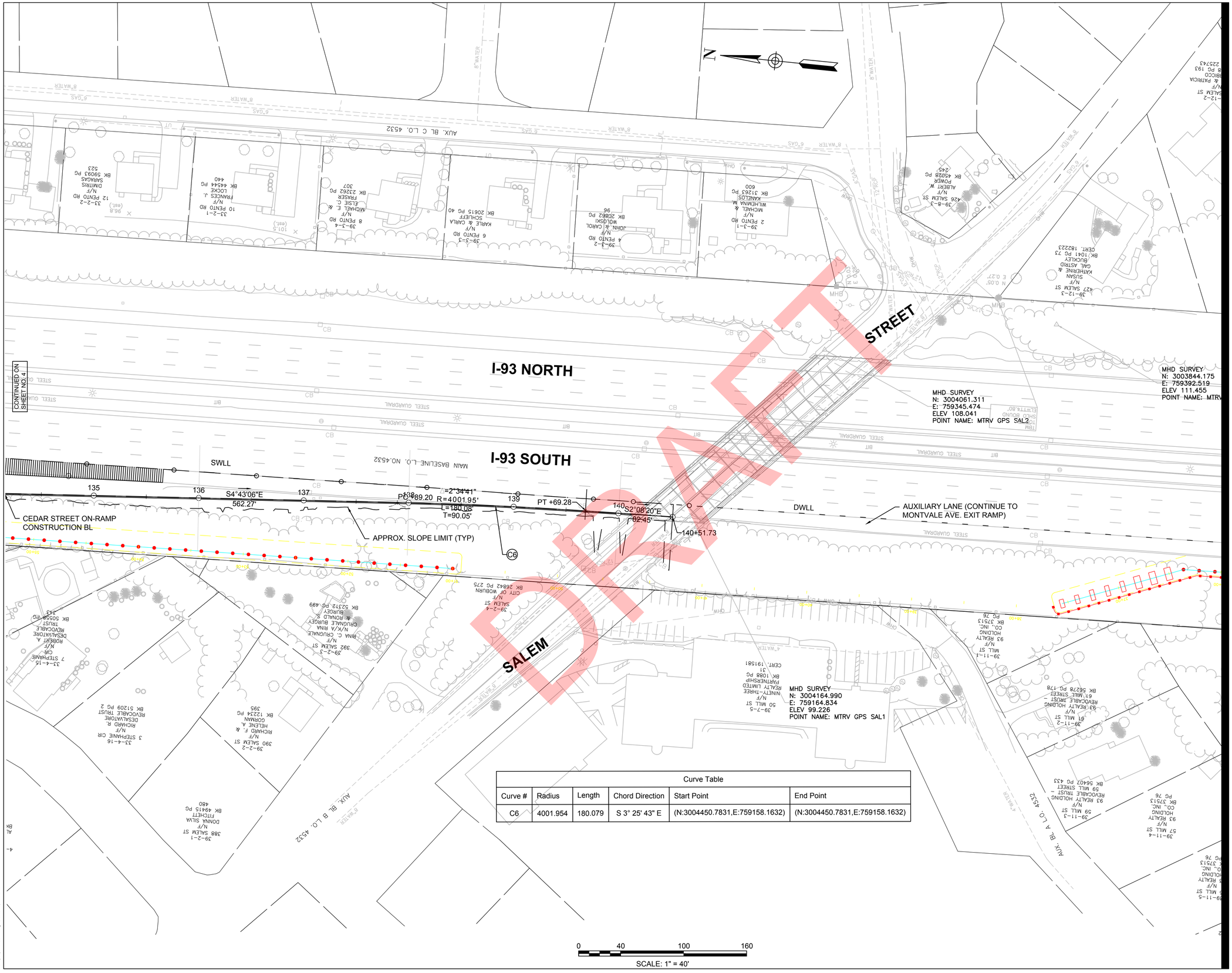
2019/02/21 2:34 PM By: Casadino, Luciana



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CITY OF WOBURN

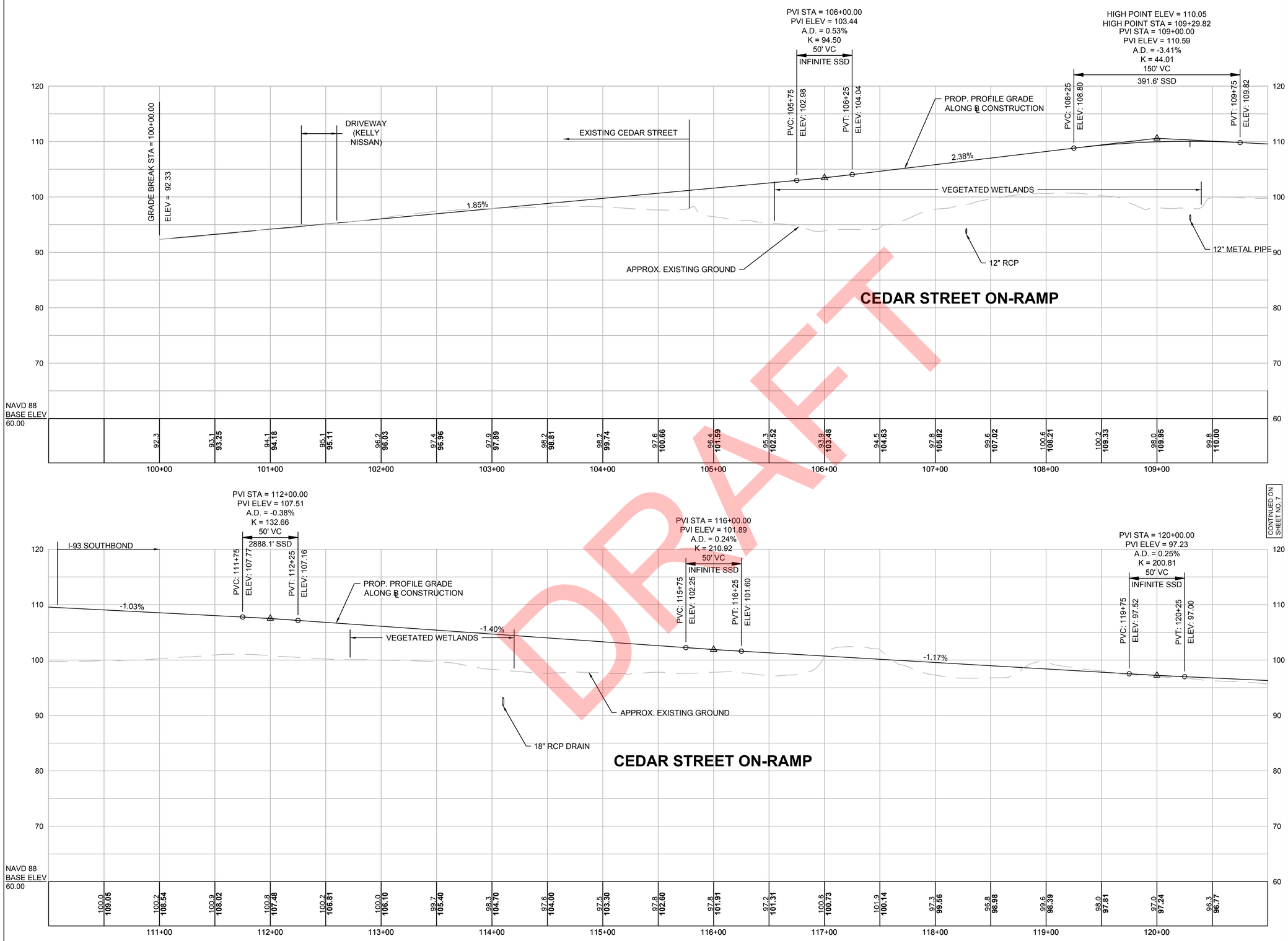
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title

CONSTRUCTION PLAN
PART 4 OF 4

Project No.	Scale	
179410749		
Drawing No.	Sheet	Revision



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2019/02/21 2:35 PM By: Casalino, Luciana

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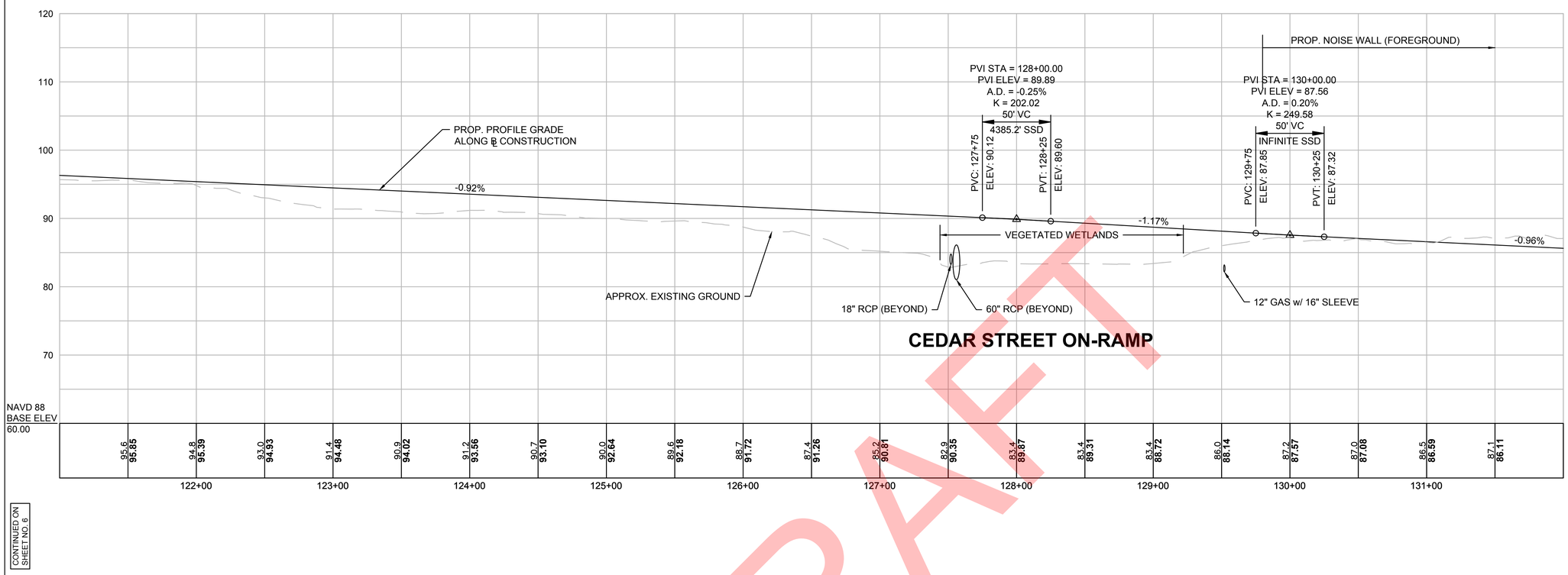
Client/Project
CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
PROFILE
PART 1 OF 2

Project No. 179410749
Scale
Drawing No.
Sheet
Revision



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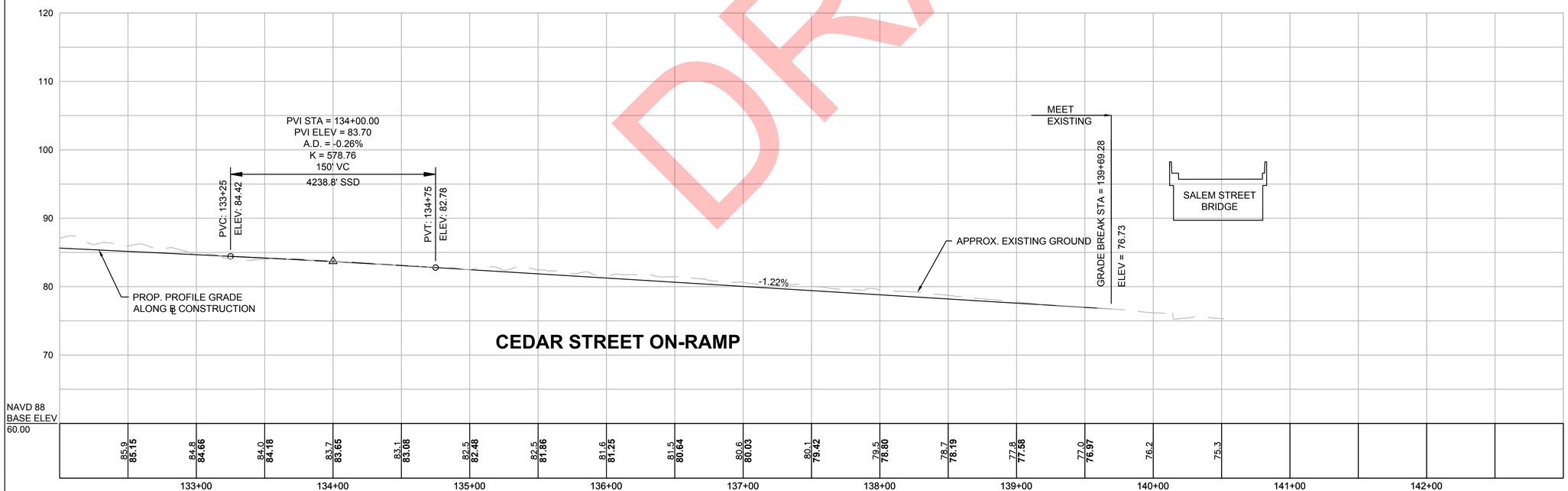

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SCALE: 1" = 40'

DRAFT

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2019/02/21 2:35 PM By: Casalino, Luciana

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CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title

PROFILE
PART 2 OF 2

Project No. 179410749

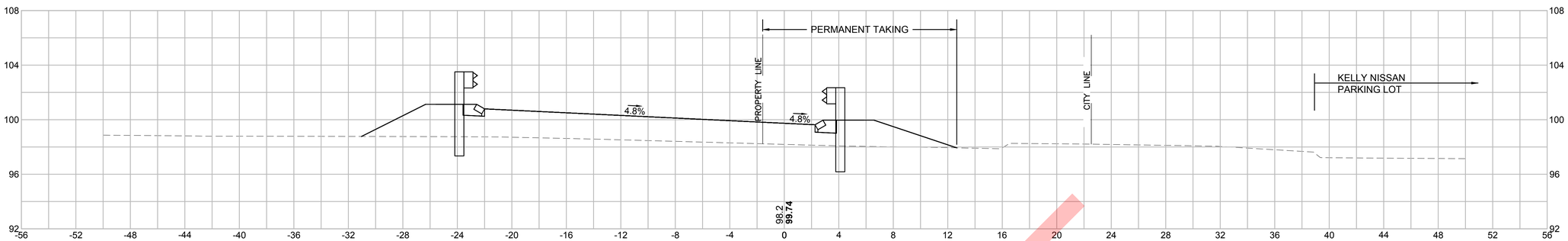
Scale

Drawing No.

Sheet

Revision

104+00



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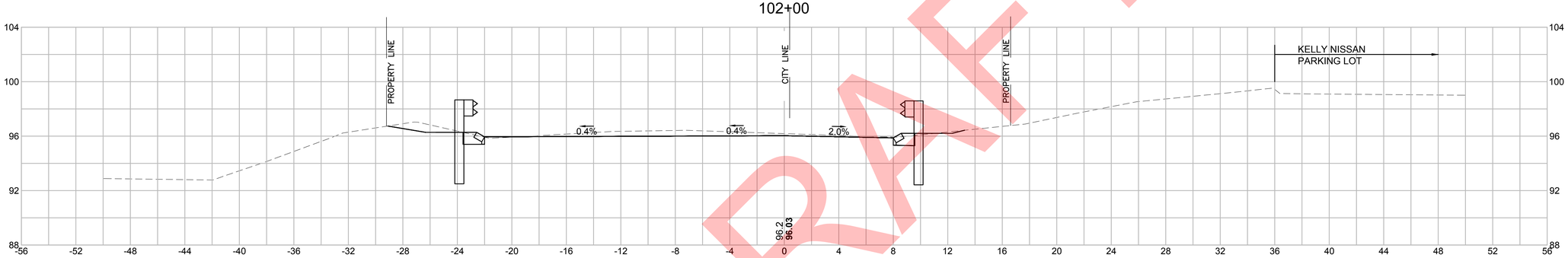

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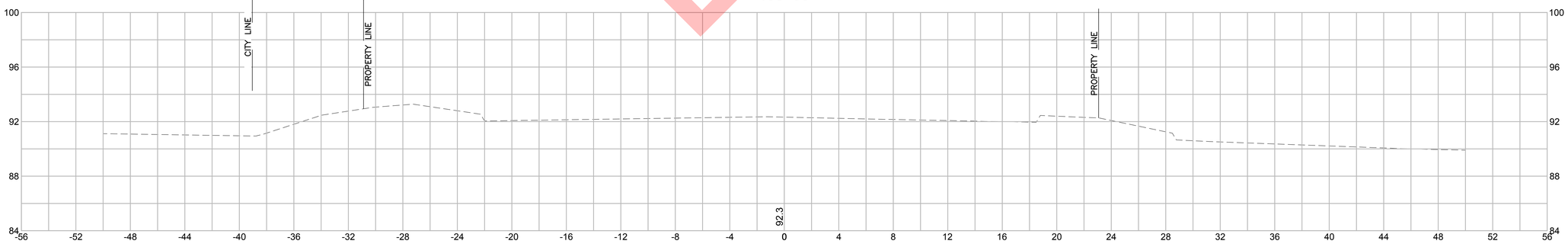

HOR. SCALE IN FEET
4 0 4 8
4 0 4 8
VER. SCALE IN FEET

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Client/Project
CITY OF WOBURN

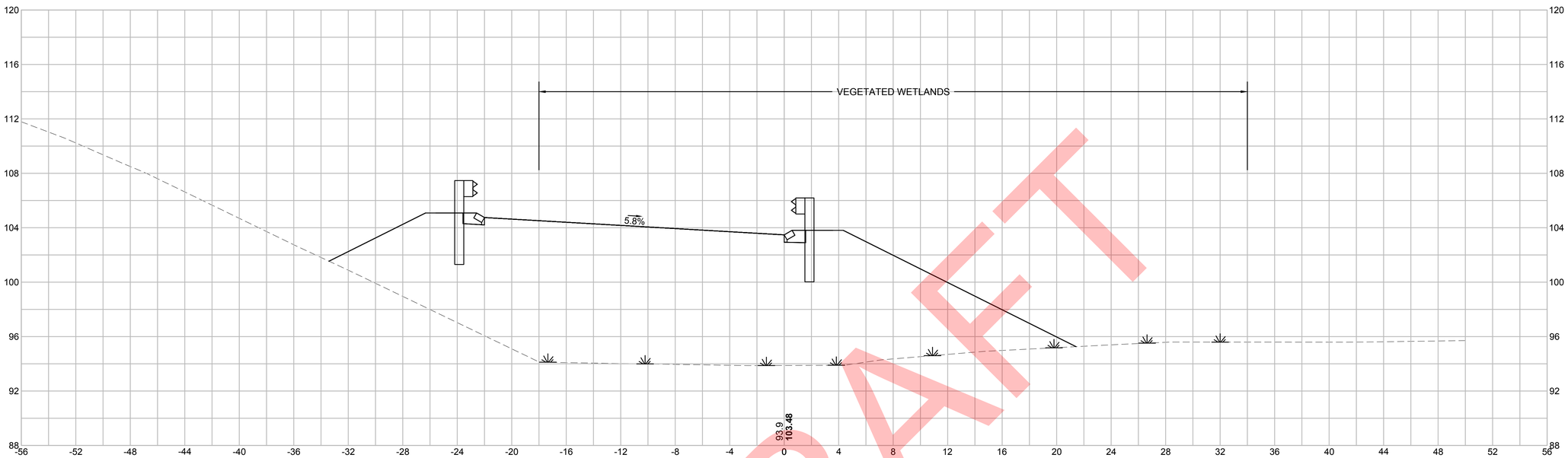
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 1 OF 11

Project No. 179410749
Scale
Drawing No.
Sheet
Revision

106+00



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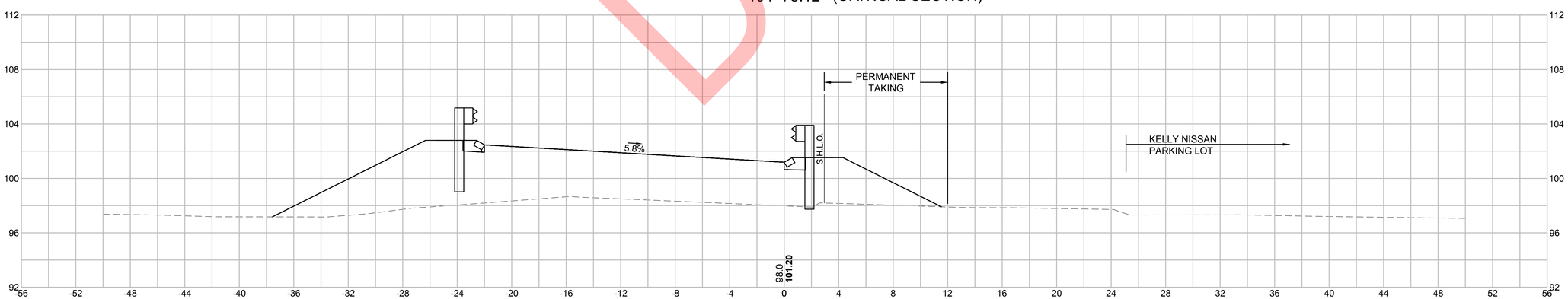

HOR. SCALE IN FEET
4 0 4 8
4 0 4 8
VER. SCALE IN FEET

DRAFT

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Client/Project
CITY OF WOBURN

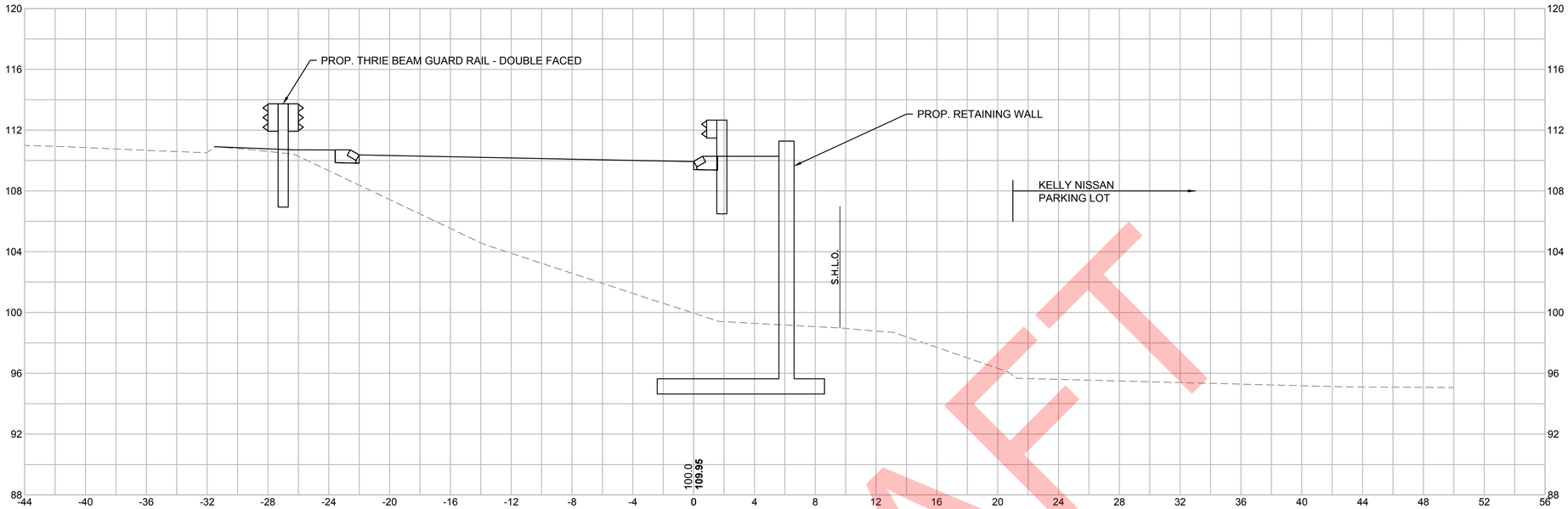
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 2 OF 11

Project No. 179410749
Scale
Drawing No.
Sheet
Revision

109+60.19 (CRITICAL SECTION)



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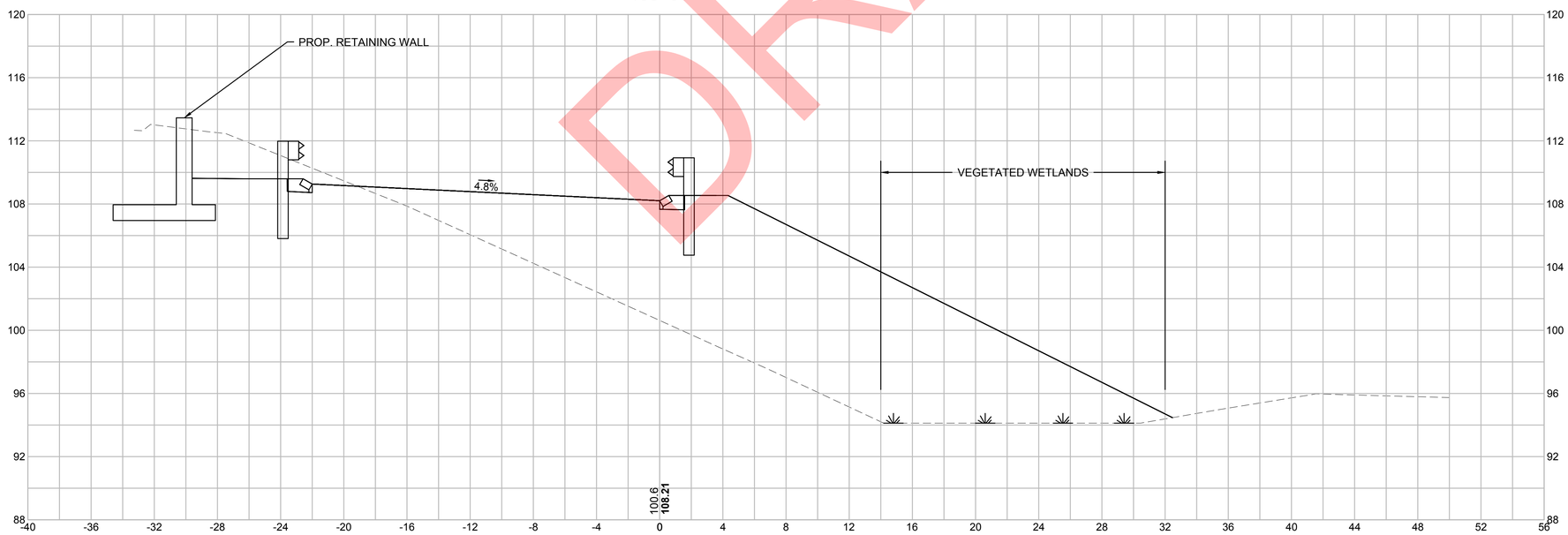

HOR. SCALE IN FEET
4 0 4 8
4 0 4 8
VER. SCALE IN FEET

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Client/Project
CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 3 OF 11

Project No. 179410749
Scale
Drawing No.
Sheet
Revision

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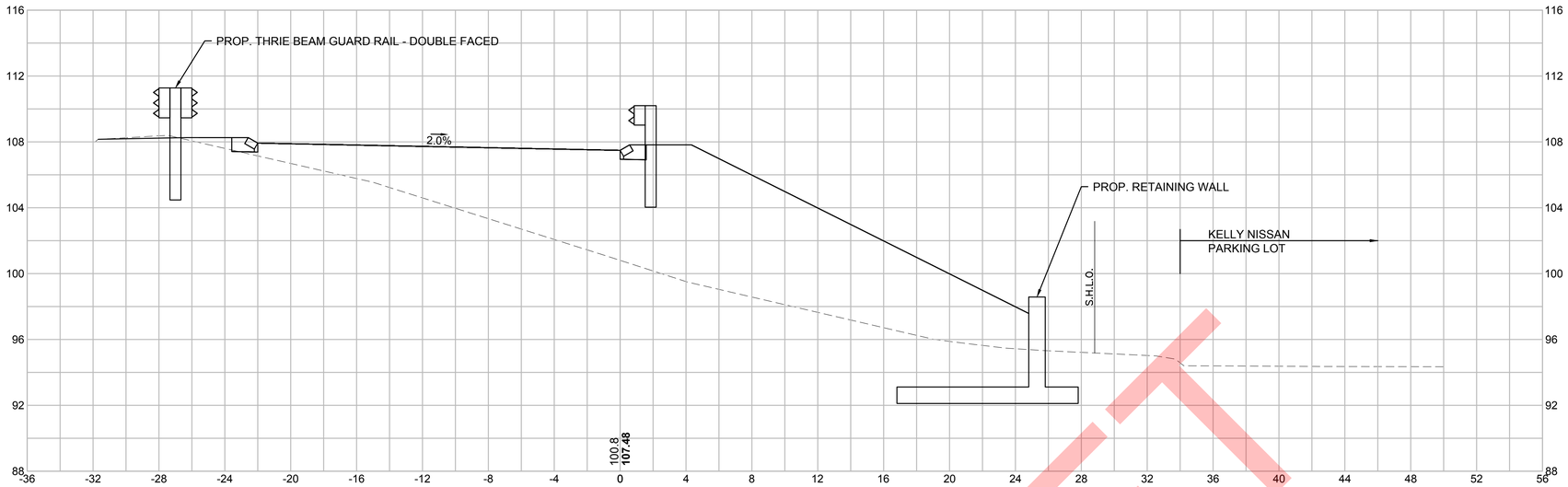
2019/02/21 3:21 PM by: Carolino, Luciana

112+00



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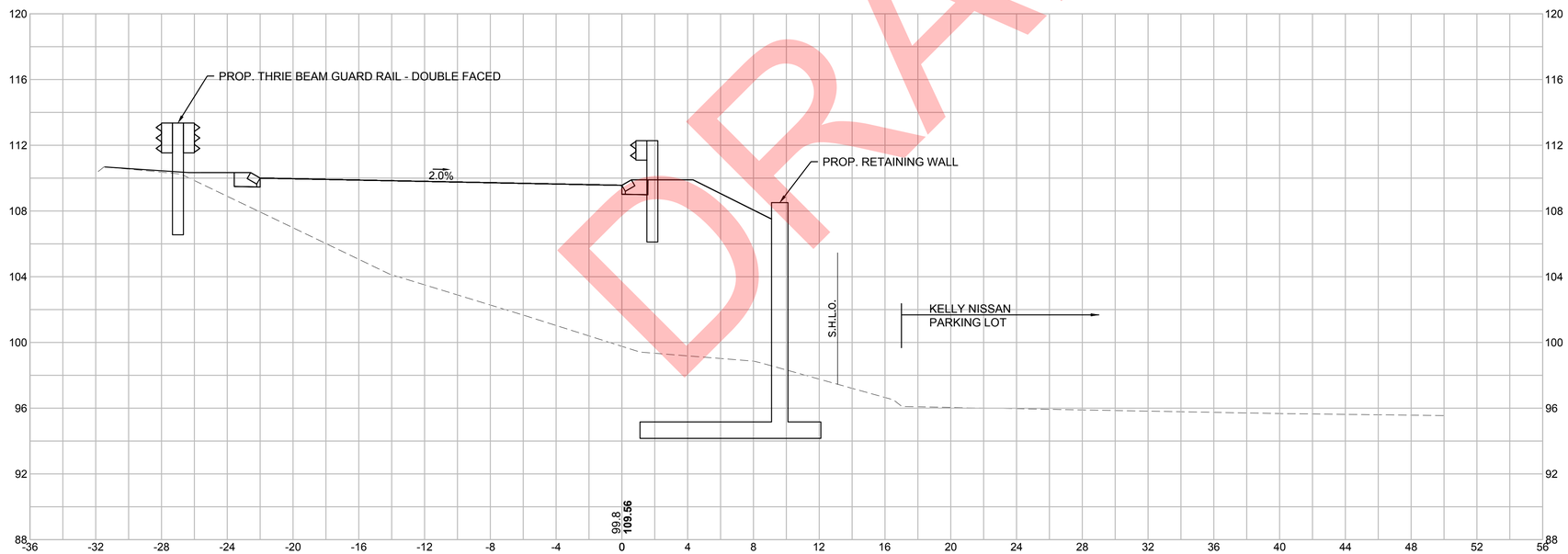

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HOR. SCALE IN FEET
4 0 4 8
4 0 4 8
VER. SCALE IN FEET

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CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 4 OF 11

Project No. 179410749
Scale
Drawing No.
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Revision

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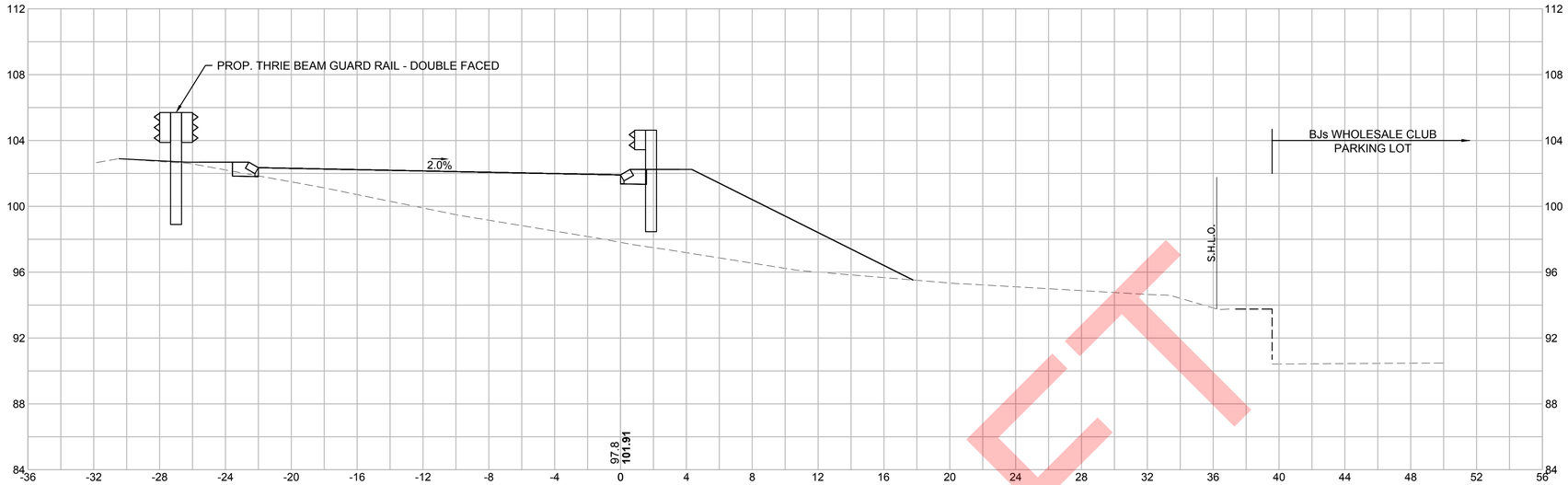
2019/02/21 3:21 PM By: Casalino, Luciana

116+00



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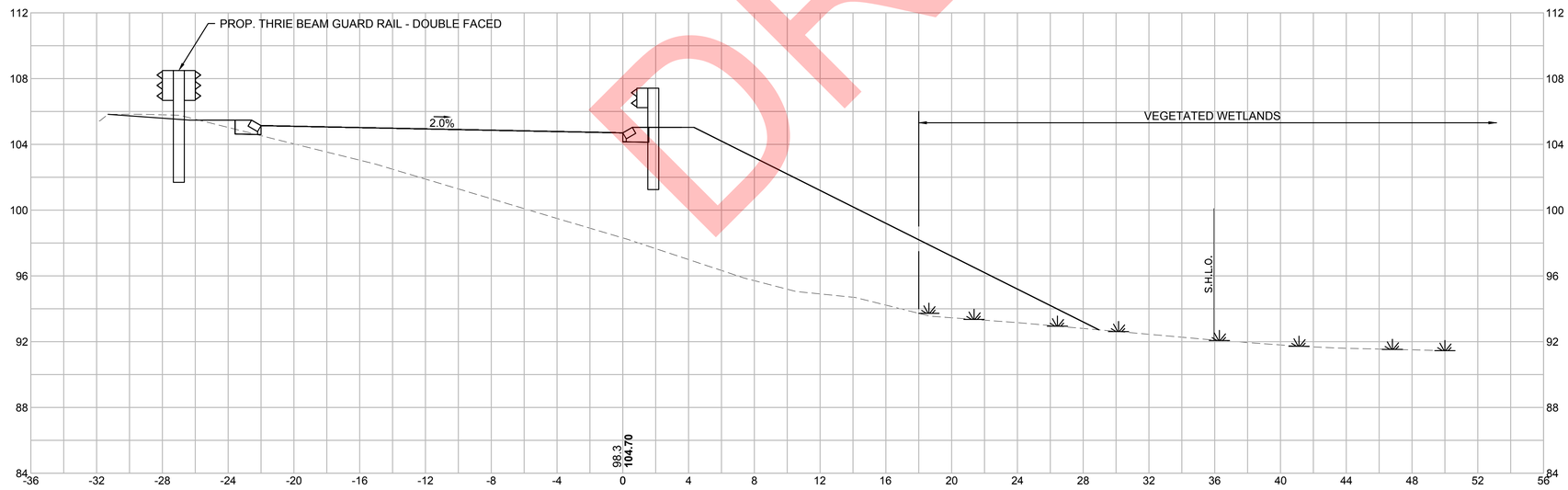

HOR. SCALE IN FEET
4 0 4 8
4 0 4 8
VER. SCALE IN FEET

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CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 5 OF 11

Project No. 179410749
Scale

Drawing No.
Sheet
Revision

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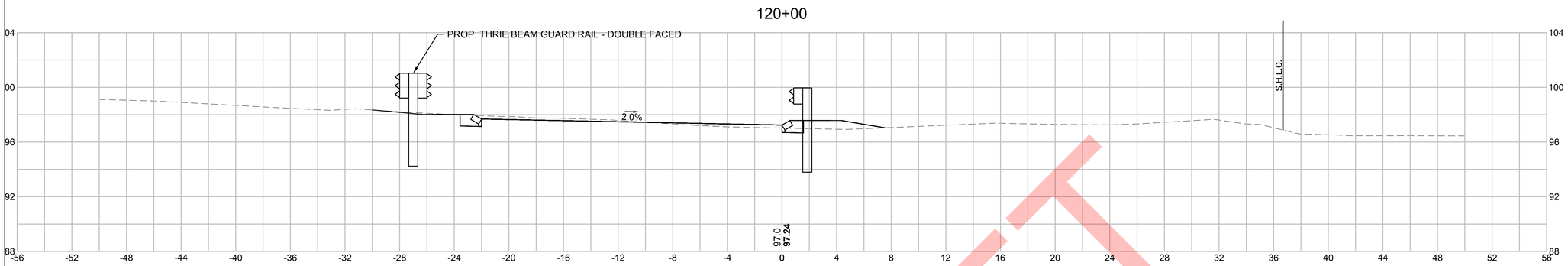
2019/02/21 3:21 PM by: Carolino, Luciana



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4 0 4 8
4 0 4 8
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CITY OF WOBURN

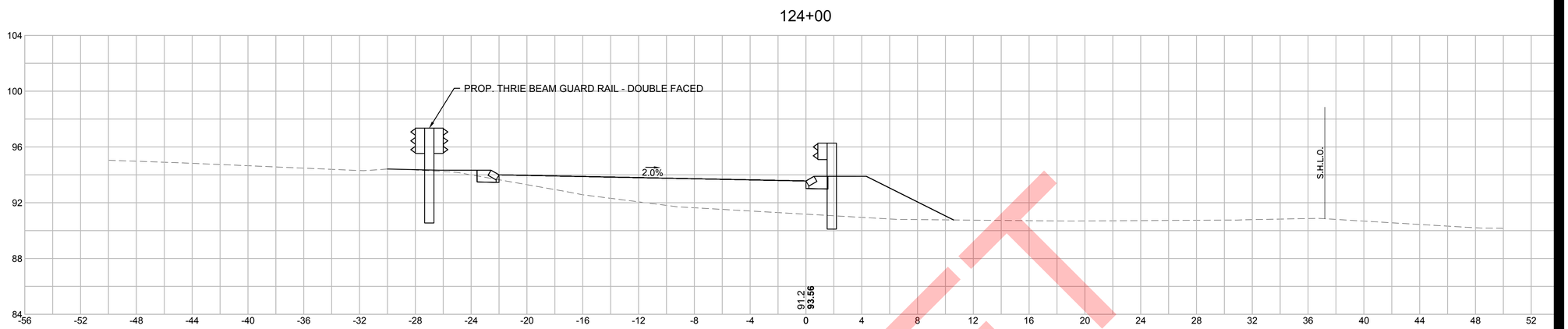
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

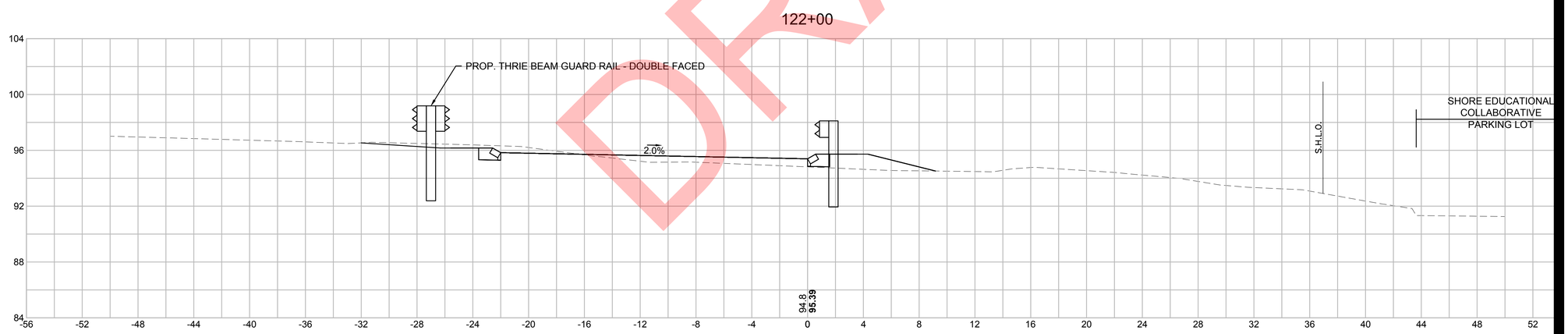
WOBURN, MA

Title
CROSS-SECTIONS
PART 6 OF 11

Project No. 179410749
Scale

Drawing No.
Sheet
Revision





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4 0 4 8
4 0 4 8
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Client/Project

CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title

CROSS-SECTIONS
PART 7 OF 11

Project No.	Scale	
179410749		
Drawing No.	Sheet	Revision

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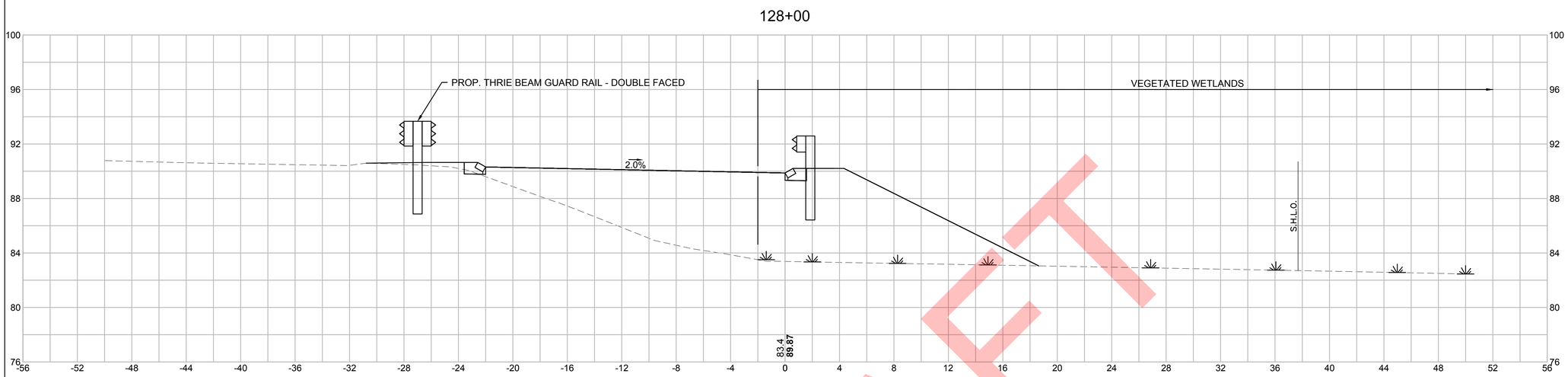
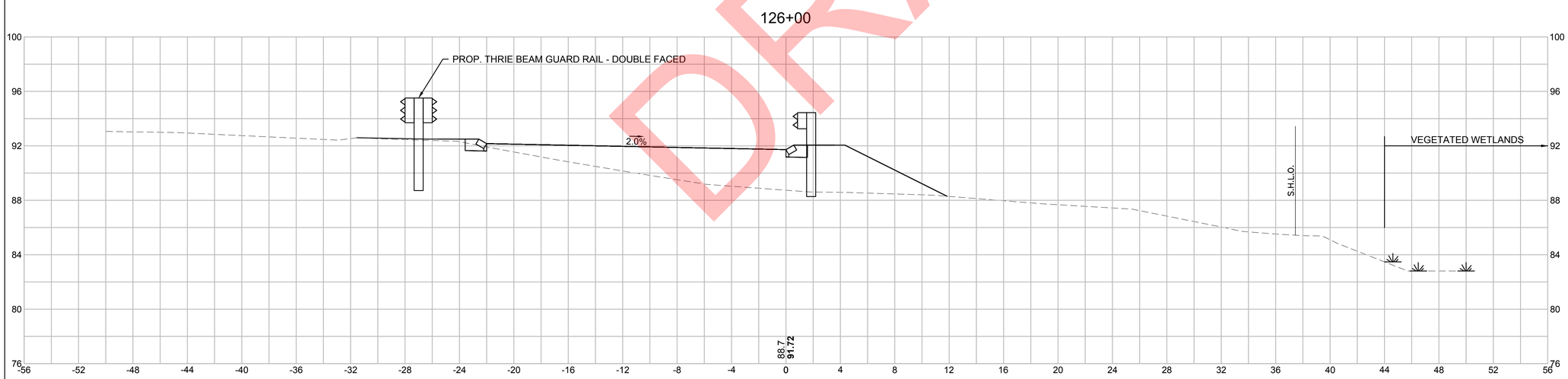
2019/02/21 3:21 PM By: Casalino, Luciana





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4 0 4 8
VER. SCALE IN FEET

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2019/02/21 3:22 PM by: Carolino, Luciana

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Client/Project
CITY OF WOBURN

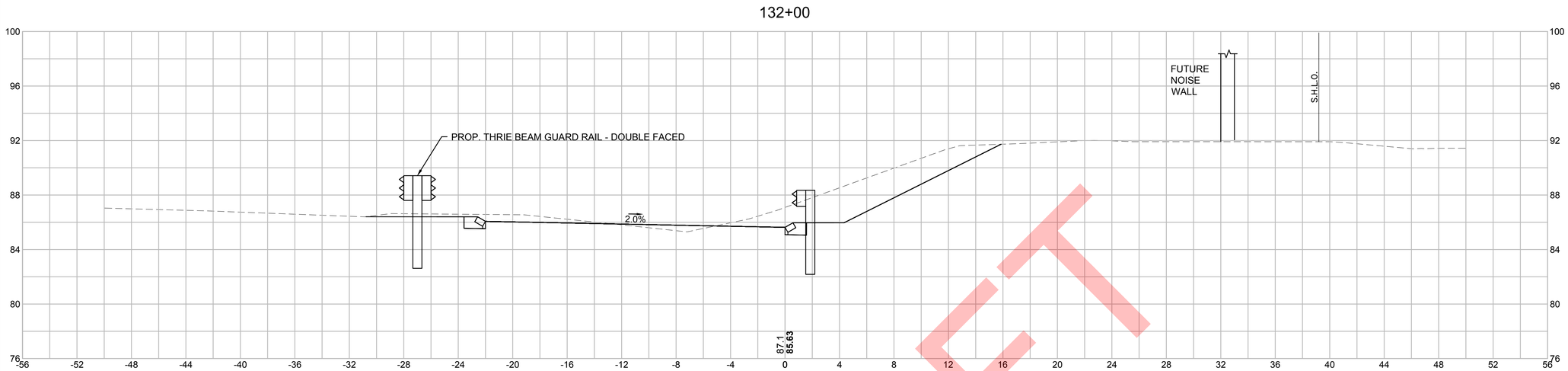
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

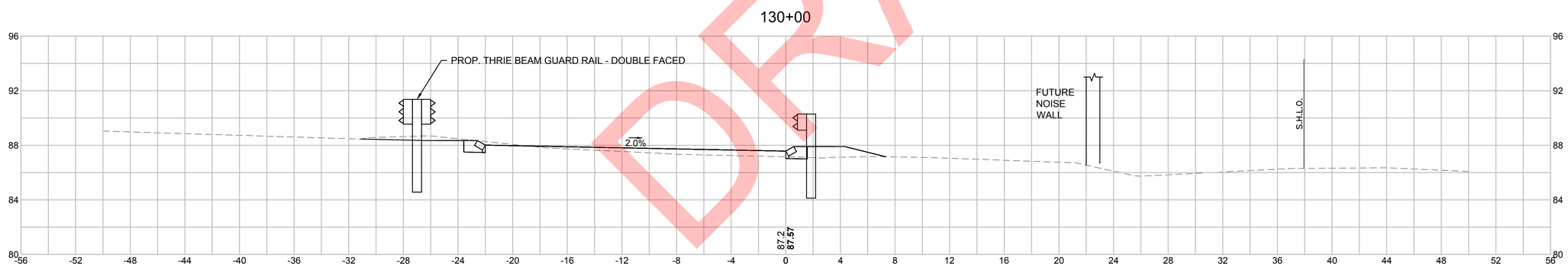
WOBURN, MA

Title
CROSS-SECTIONS
PART 8 OF 11

Project No. 179410749
Scale

Drawing No.
Sheet
Revision





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Client/Project
CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 9 OF 11

Project No. 179410749
Scale
Drawing No.
Sheet
Revision

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2019/02/21 3:22 PM by: Cardino, Luciana

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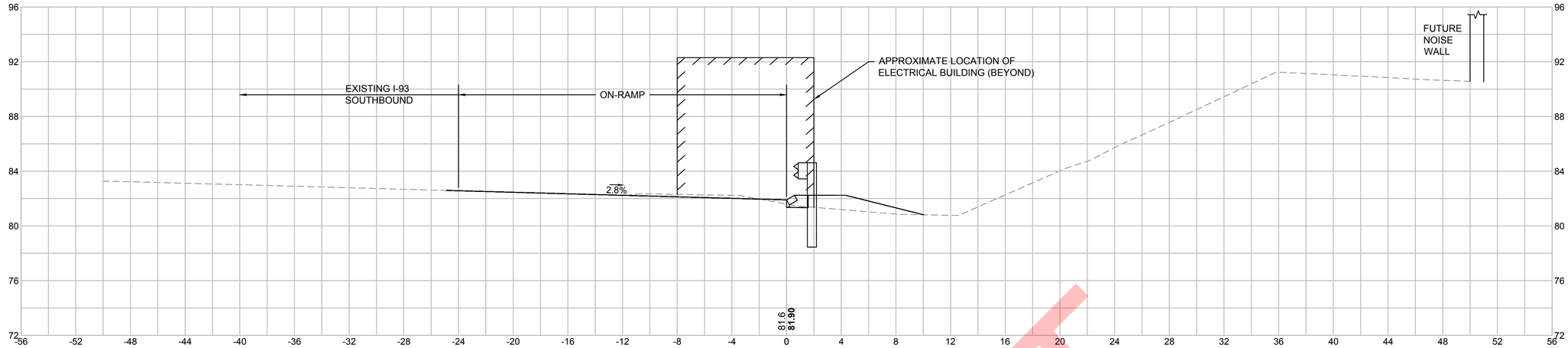

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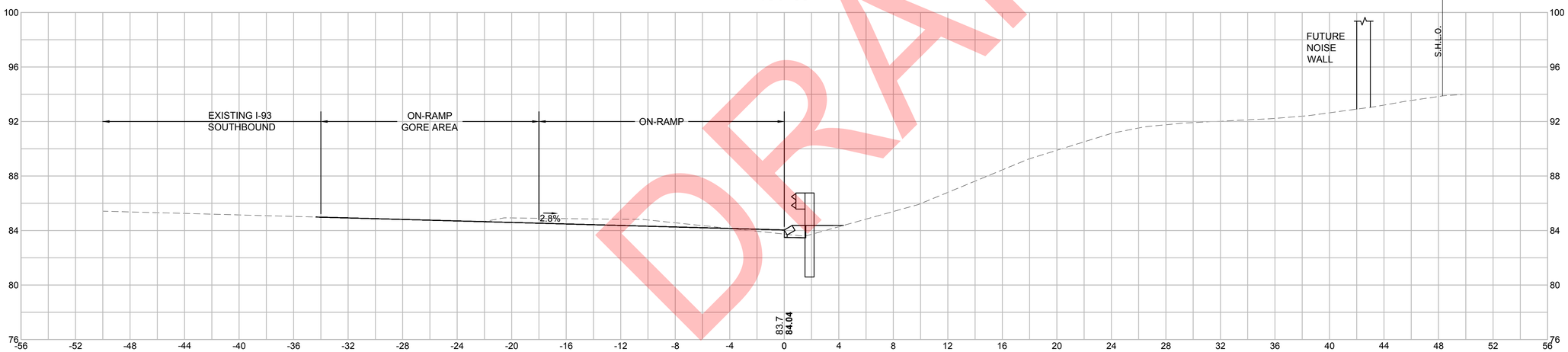

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4 0 4 8
VER. SCALE IN FEET

DRAFT

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Client/Project
CITY OF WOBURN

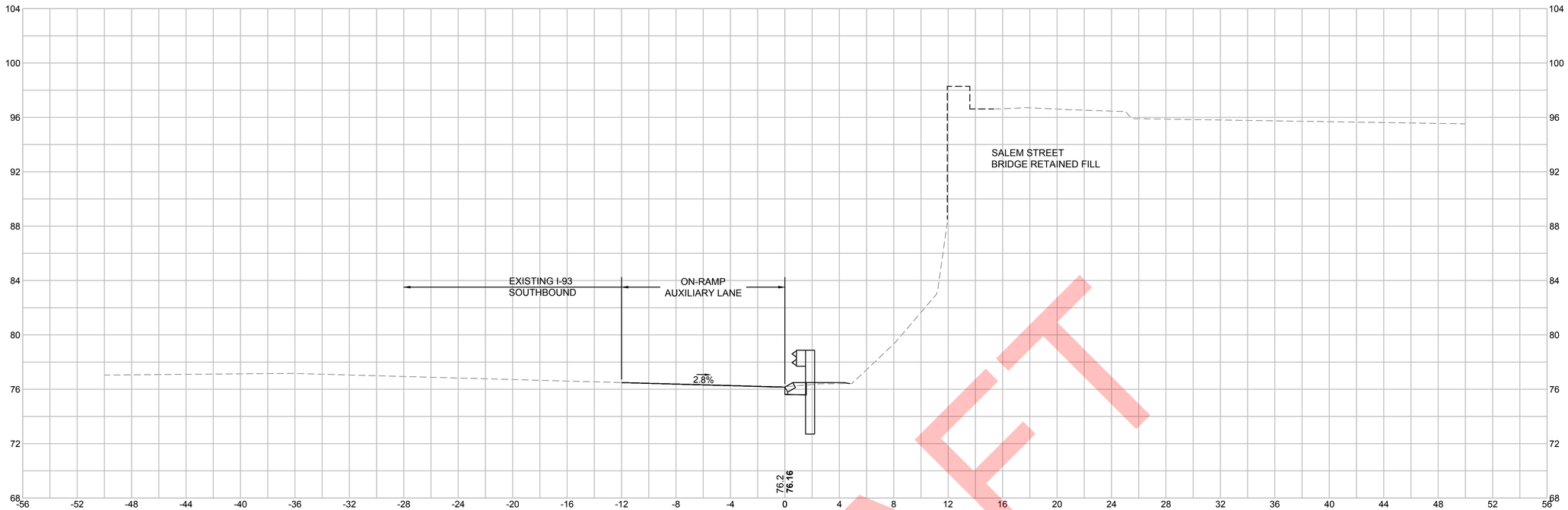
CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 10 OF 11

Project No. 179410749
Scale
Drawing No.
Sheet
Revision

140+00



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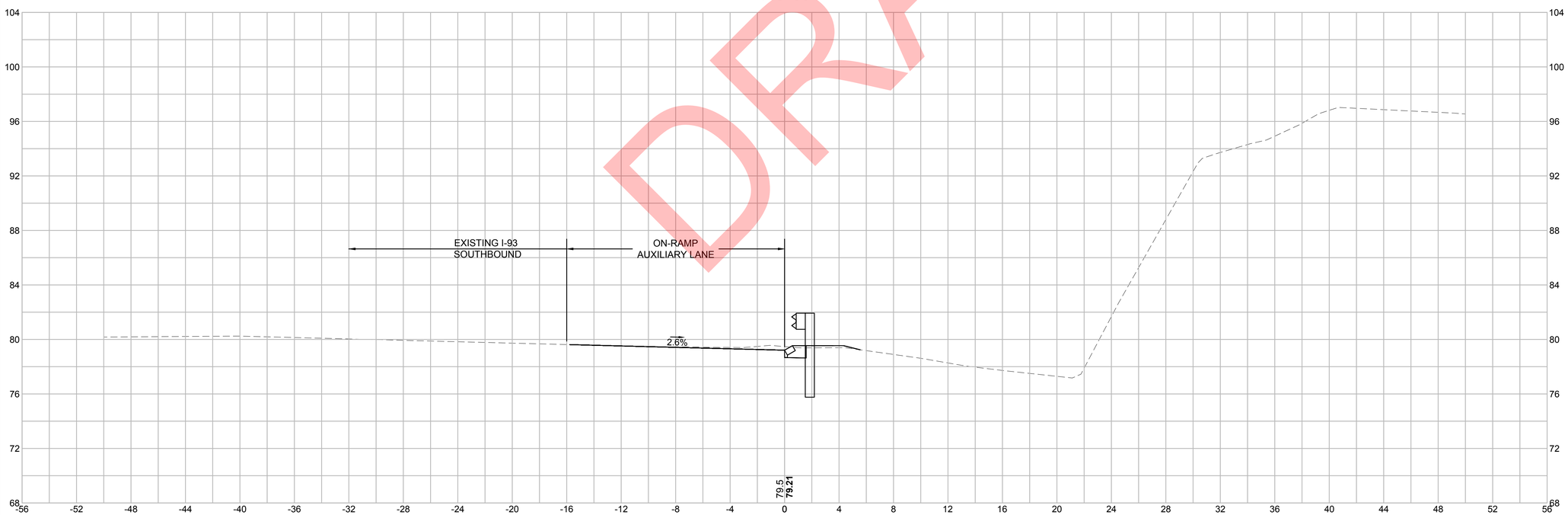

HOR. SCALE IN FEET
4 0 4 8
4 0 4 8
VER. SCALE IN FEET

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Client/Project
CITY OF WOBURN

CEDAR STREET ON-RAMP
FEASIBILITY STUDY

WOBURN, MA

Title
CROSS-SECTIONS
PART 11 OF 11

Project No. 179410749
Scale
Drawing No.
Sheet
Revision