# Yield Roadway

## Options for Chandler Mill Road

## Executive Summary

Yield Roadways offers a low-cost option for beginning to create a recreation and active transportation route in less developed regions wherever there are roads with relatively low volumes and immediate connections to neighborhoods and community assets.

Chandler Mill Road is a quiet local road used by about 40 pedestrians and cyclists each day. The current plan (described in detail in a March 2021 engineering report with modifications captured in an April 2022 presentation to Township Supervisors and in updated drawings from July 2022) calls for construction of a 6-8' wide sidepath along the length of the road to accommodate pedestrians of all ages and abilities. The plan is controversial:

- It is projected to cost of $7M for a 7400' 6'-8' wide sidepath, making it one of the most expensive in the region
- It would destroy 400 trees.
- It requires the reconstruction of hundreds of feet of streambank where there is insufficient room for a sidepath and the roadway, even reduced to 12' in width.
- There is no evidence that it would drop traffic speed to the extent needed to make the roadway comfortable for cyclists of all ages and abilities.
- Property owners on the southern half have been extremely reluctant to cede the land required for the Right of Way (RoW). Township supervisors confirmed, however, that they will not resort to eminent domain to salvage the current plan.
- The design team and township manager claim that construction must begin soon or grant funding will be lost
- While advocates have claimed that the sidepath can be part of a future, long-distance greenway, our analyses indicate that such a greenway is extremely unlikely to ever be built because of its extraordinary cost and the lack of a clearly established RoW along key sections of the proposed route.

Our proposal centers on piloting a yield roadway on at least part of the road. We believe that targeted and incremental traffic calming, relatively minor improvements, and community outreach could create a low stress route suitable for pedestrians and cyclists of all ages and abilities at a low cost. Our proposal would immediately solve all of the problems listed above: it would preclude the need to seize public land, save millions of dollars in costs, spare hundreds of trees, and allow streambank reconstruction to focus only on those sections that truly need it. We describe this in greater detail below,

referencing the characteristics of the original roadway, the current plan, and our proposal. We outline several possible courses of action.

- More information is available on **Kennett Outdoors** regarding our **Healthy Outdoors** goal for Kennett residents, referencing the **journey of a young woman** and her family to become healthy outdoors despite her disabilities.

# The Route

## Yield Roadway Design

Our proposal centers on converting sections of Chandler Mill Road into a Yield Roadway design (this design is described in greater detail on Kennett Outdoors). In sum, Yield Roadways are local roads with low speeds, low volumes, and no centerline. The absence of centerlines naturally calms traffic by lowering speeds and increasing the vigilance of drivers.If needed, speed cushions and other measures can be added to lower speed still more. Yield Roadways also give drivers more freedom to shift into the opposite lane to give cyclists and pedestrians more room, and thus help them to feel more comfortable . Yield Roadways can also incorporate dashed lines to suggest edge lanes for cyclists and pedestrians, and increase their comfort further still.

To establish whether the existing road and current plan could create the potential to become a Yield Roadway, we can number **Opportunities** and **Challenges** with respect to the characteristics of the road and the traffic. This helps to shape the immediate opportunities for improvement captured in our proposal.

**1. Type of road.** Extremely low volumes (see below) classify this as a low volume rural minor access road, ideal for a Yield Roadway.

**2. Prevailing speeds.** Yield Roadways can potentially be installed with prevailing speeds (e.g., the 85th %ile of drivers) under 30mph, with speeds of 20mph preferred.

- Prevailing speeds on the original roadway were too high for a Yield Roadway. In a traffic study conducted in January 2021 without any traffic calming and with the speed limit set at 35mph, prevailing speeds ranged from 36 to 42 mph.
- The current plan would likely decrease prevailing speeds, though not quite enough for a Yield Roadway. A traffic study conducted in October 2021 recorded prevailing speeds ranging from 31 to 33 mph in sections with traffic calming (one-lane two way yield sections) and after the speed limit had been reduced to 25 mph. At both times, higher speeds were recorded north of Oriole Drive. The current plan proposes a mix of traffic calming measures (a total of 12 speed humps and one-way yield sections) over the principal 6400 foot section from Hillendale to Round Hill Road. It is not clear if the number and type of measures would be adequate.

- Our proposal would aim to decrease prevailing speeds to below 30mph by removing the centerline and through targeted and incremental traffic calming (see below).

**3. Traffic counts**. Yield Roadways can potentially be installed with daily traffic volumes under 2000 vehicles/day, with volumes of 400 vehicles/day preferred. Traffic volumes on the original roadway were already optimal. In the October 2021 traffic study, counts ranged from 110 to 227 vehicles per day. The highest volumes were recorded north of Oriole Drive. These extremely low traffic volumes dramatically decrease the risk of collisions and allows designers to draw on different design standards that offer more flexibility.

**4. Width of roadway.** The original roadway is relatively narrow - around 18' in many places - with no shoulders. Yield roadways are typically installed on narrow roads, even those as narrow as 12'.

**5. Centerlines.** The original roadway has a centerline, and the current plan would retain this. Our proposal would eliminate the centerline.

**6. Limited Sight Distance (LSD).** Analysis of the original roadway focussed on three LSD sections between Hillendale and Round Hill Rds. These assumed prevailing speeds of 35 mph and stopping sight distances (SSD) of 205'. There may be a fourth LSD between Round Hill Rd and the bridge.

- The current plan includes shaving of embankments at two LSD sections, and adding a 9' wide 600' long boardwalk at the third. No evidence has been provided to confirm that this would be sufficient to assure appropriate sight distances without a corresponding decrease in prevailing speed below 35mph.
- Our proposal would address LSDs with targeted traffic calming until speeds had been reduced and sight distance resolved. This could be conducted in combination with shaving of embankments or a parallel boardwalk if needed (see below). We also question the designer's decision to designate the LSDs as "higher risk locations", presumably because of "sharp curves". We would argue that at least one of these curves (with a radius of 435') is not sharp enough to merit that classification, and so believe that a stopping sight distance of 170' corresponding to a lower risk location would be more appropriate (see below).

## Other factors related to safety, stress, and effort

**7. Bicycle Level of Traffic Stress (LTS).** To meet the project's goals of being appropriate for cyclists of all ages and abilities, the roadway must achieve an LTS rating of 1. We generally rely on Furth's 2022 rubric, using criteria 1-5 above, with two exceptions: 1) we adjust for LSDs - though these are not incorporated into this rubric but are recognized as significantly increasing traffic stress, and 2) we set the threshold for an LTS

rating of 1 for this road at 30 mph, given that this threshold is used elsewhere, and in the light of the extremely low volumes noted here.

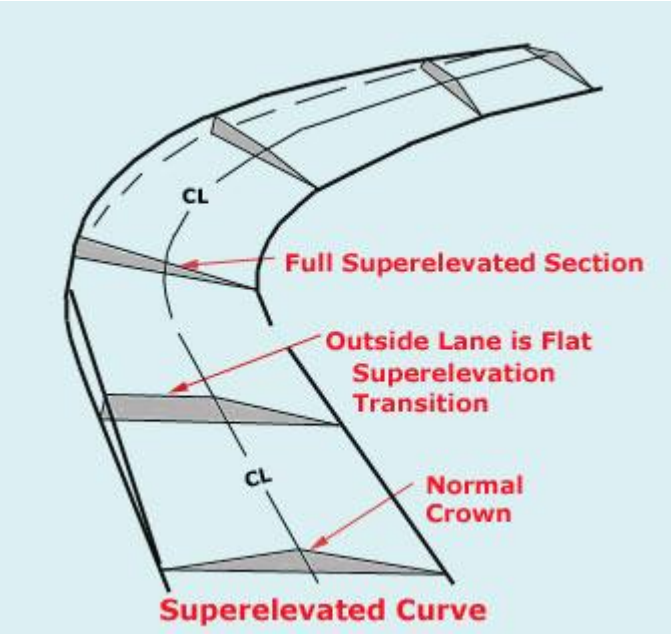
- The original roadway would merit an LTS rating of 3. DVPRC's LTS 2 rating did not take into account either the LSDs or the prevailing speeds up to 42mph. An LTS rating of 3 renders this route uncomfortable for all but a small proportion of interested cyclists.
- There is no evidence that the current plan would result in an LTS rating of 1. An LTS rating of 2 would be warranted if the shaved embankments eliminated two of the LSDs, and if cyclists could use the boardwalk to circumvent the third LSD. But no evidence has been provided that the shaved embankments would eliminate these LSDs, and the boardwalk would have to be 10' wide to meet minimum requirements for a shared use path given its 600 ' length (paths can be narrowed for short distances to avoid certain obstacles). Even then, there would have to be evidence that prevailing speeds could be dropped below 30 mph to merit an LTS rating of 1.
- Our proposal would aim to decrease prevailing speeds to eliminate LSDs using targeted traffic calming until speed drops to 25 mph at critical points. This may be sufficient to decrease overall prevailing speeds below 30 mph (especially when combined with the natural calming effects of the yield roadway design), meriting an LTS rating of 1. If not, we would propose additional traffic calming measures.

**8. Intersections.** Both roads that intersect with Chandler Mill have stop signs.

**9. Safety.** There is no history of accidents on these roads according to police records.

**10. Accessibility.**

There are no running grades that would make wheelchair users uncomfortable, but there are multiple sections with cross-grades that exceed the 2% maximum recommended. Cross-grades exceeding 2% make it difficult for wheelchair users from maintaining a straight line. Such cross grades are typically found where curves have been slanted (superelevated - see right)) to prevent a speeding car from sliding off of the roadway. Some cross-grades greater than 2% may also occur where there is excessive crowning. 1.5-2% of crowning is recommended for all roadways to help with run-off (see right).



- The March 2021 design document indicated that the original roadway included 8 curves with superelevations greater than 2%, in some cases exceeding the maximum recommended superelevation for such curves.
- The current plan identified curves with superelevation in the course of assessing concerns for stopping sight distance on curves (see above). Though engineers could address excessive superelevation in the course of repaving, they have not elected to do so (they are only obligated if there is a history of accidents).
- Our proposal would seek to re-evaluate superelevation in the light of traffic calming which may well justify a reduction in speeds at specific corners (if not overall design speed). As described below, this eliminates the need for superelevations greater than 2% on all curves. We expect that most of the cross-grades greater than 2% can be easily corrected during the repaving process at a minimal cost relative to the current plan.

## Healthy Outdoors

**11. Connections to Neighborhoods.** A total of 104 households connect to the road: 14 on Chandler Mill itself, 37 on Round Hill / Hilltop, and 53 in the Falcon"s Lair development. But only 51 of these have easy access (e.g., are within a half-mile) of Chandler Mill.

**12. Exercise and Recreation.** At the present time, this likely meets the needs of a limited number of walkers, runners, and cyclists because of the high levels of traffic stress noted above. If traffic stress can be lowered, the road could meet the exercise needs for all but more advanced runners and cyclists. Our proposal is designed to offer a safe and comfortable exercise route for all users.

**13. Active Transportation.** Chandler Mill connects to the 60 acre Chandler Mill Nature Preserve and the Historic Bucktoe Cemetery. At the present time, this only offers active transportation opportunities to more advanced walkers and cyclists because of the high levels of traffic stress noted above. Our proposal is designed to offer a safe and comfortable route to the Chandler Mill Nature Preserve for all users.

**14. Connections to Nature** The route passes through quiet, natural settings, though the current plan requires cutting down hundreds of trees, pushing the canopy back by 20-30 feet along the entire western side of the road. Our proposal would make it unnecessary to cut down any trees.

## Conclusion: A Yield Roadway clearly offers the potential for immediate benefits to 50-100 households at significantly decreased costs and environmental impact

In general, Chandler Mill has excellent potential to immediately help about 50-100 Kennett Township households be Healthy Outdoors. A Yield Roadway offers important potential improvements over the current plan.

It is clear that the original roadway would not be comfortable for many pedestrians and cyclists, especially those who are less experienced and familiar with the road. Improvements to the roadway could offer immediate benefits to residents.

Current Plan. Aside from its exorbitant cost and environmental impact, there is no evidence that the current plan will reduce speeds to below 30 mph and eliminate LSDs as needed to ensure that the road is comfortable for all cyclists. It is possible that the boardwalk and the shaved embankments are designed to eliminate LSDs, assuming prevailing speeds of 35 mph. If so, this would improve the LTS rating to 2, but this would still leave the roadway unsuitable for many cyclists. To ensure that the roadway is suitable for all cyclists, the current plan must be able to reduce prevailing speeds below 30 mph.

Our Proposal. Our analysis indicate that there are three barriers to implementing a Yield Roadway to ensure that the road meets the needs of all users: a) cross-slopes greater than 2% due to excessive crowning and superelevation, b) LSDs, and c) overall prevailing speeds greater than 30 mph. We outline a plan to address each of these in turn, and outline other considerations (like a reduction in the overall design speed, and addressing concerns among residents through outreach and education).

*LSDs*

Our proposal for addressing LSDs is based on the *targeted traffic calming* originally referenced in our June 2021 proposal. The first step requires removing the centerline (e.g., by painting over it), which is itself expected to reduce traffic speed.

The second step is to re-evaluate the SSD required given the type of location. The March 2021 study identified LSDs assuming speeds of 35 mph (see Table 5 below). Note that a 3rd LSD was identified between curve number 1 and 2 because of a high embankment.

The March 2021 report identified these as “high risk” locations, presumably because these were considered “sharp curves”. We would suggest that a curve with a radius greater than 400’ would not be considered a sharp curve and so would count as a lower risk location, only requiring an SSD of 170’ (see Table 4-7 below, from the 2019 federal guide for Low Volume Roads cited by the traffic engineers). This may resolve the one LSD at curve

number 7 .

**Table 5. Chandler Mill Road Horizontal Curvature Between Hillendale Road and Round Hill Road**

| Curve No. | PI Sta. | Superelevatred[1] | Radius[1] | Stopping Sight Distance[2] |
|---|---|---|---|---|
| 1 | 30+40 | Y 6.5% | 170 | Available |
| 2 | 31+83 | Y 6.1% | 450 | Available |
| 3 | 37+13 | Y 5.8% | 415 | Available |
| 4 | 49+22 | Y 5.3% | 450 | Available |
| 5 | 53+67 | Y 7.9% | 235 | Limited |
| 6 | 56+88 | Y 8.5% | 310 | Available |
| 7 | 65+90 | Y 4.5% | 425 | Limited |
| 8 | 72+62 | N | 500 | Available |
| 9 | 77+21 | Y 3.0% | 450 | Available |

(1) Approximated value based on existing topographic information and best-fit alignment

(2) Based on Table 4-7 from the American Association of State Highway Officials (AASHTO) Guidelines for Geometric Design of Low-Volume Roads, Second Edition (2019): 205 Feet minimum.

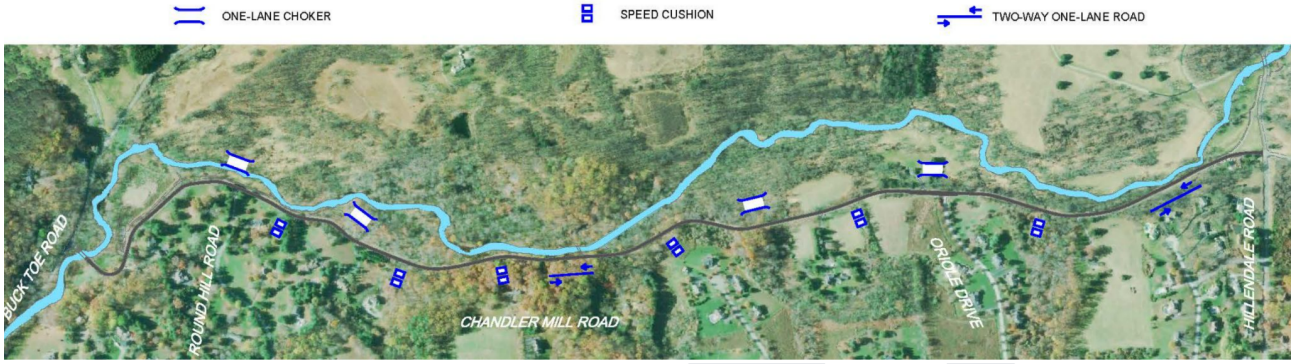
**Table 4-7. Design Stopping Sight Distance Guidelines for New Construction of Low-Volume Roads with Design Volumes of 2,000 Vehicles per Day or Less**

| U.S. Customary | | | | | |
|---|---|---|---|---|---|
| | Minimum Sight Distance (ft) for Specified Design Traffic Volumes and Location Types | | | | |
| | 0–100 veh/day | 101–250 veh/day | | 251–400 veh/day | 401–2,000 veh/day |
| Design Speed (mph) | All Locations | "Lower Risk" Locations[1] | "Higher Risk" Locations[2] | All Locations | All Locations |
| 15 | 65 | 65 | 65 | 65 | 80 |
| 20 | 90 | 90 | 95 | 95 | 115 |
| 25 | 115 | 115 | 125 | 125 | 155 |
| 30 | 135 | 135 | 165 | 165 | 200 |
| 35 | 170 | 170 | 205 | 205 | 250 |
| 40 | 215 | 215 | 250 | 250 | 305 |
| 45 | 260 | 260 | 300 | 300 | 360 |
| 50 | 310 | 310 | 350 | 350 | 425 |
| 55 | 365 | 365 | 405 | 405 | 495 |
| 60 | 435 | 435 | 470 | 470 | 570 |

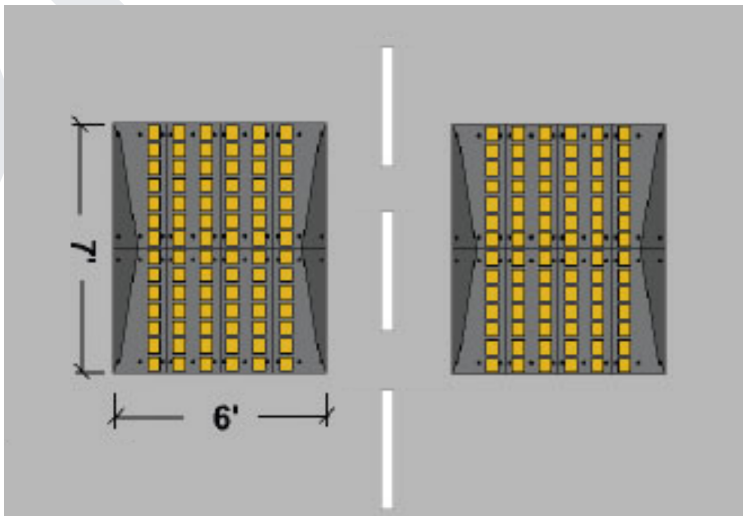
The third step is to establish the speed at which the LSD is resolved - the target speed. If LSDs are resolved at prevailing speeds of 25 mph, then 25 mph becomes the target speed. For example, an SSD of only 125 feet is required at a speed of 25 mph. If any of the LSDs require reducing prevailing speeds even lower than 25 mph, then that becomes the target speed.

Once the target speed is established, we propose to pilot *targeted traffic calming*, in this case involving placement of speed cushions at LSDs until prevailing speeds are reduced to the target speed at each of the three LSDs, or more as needed. If the LSDs are resolved with targeted traffic calming, designers may no longer need to shave embankments or build a boardwalk, decreasing costs and environmental impacts. The current plan already envisions the placement of speed cushions at 6 locations along the roadway (see below).

## Recommended Traffic Calming along Chandler Mill Road




Targeted traffic calming at LSDs involves the strategic placement of pairs of 6' wide speed cushions. Speed cushions are placed one in each lane leaving about 2' gap in between (see diagram below representing the 18' wide roadway). Two pairs of speed cushions are placed on either side of the LSDs. Ideally, one pair of speed cushions is placed where the LSD starts, and the second is placed 150-200' before it to maximize the likelihood of the needed speed reductions. Because speed cushions are generally effective at reducing speeds to 25 or even 20 mph, we can be confident that a speed cushion placed where the LSD begins ensures that we only need an SSD of 125', or possibly as little as 90' if speed drops to 20 mph (see Table 4.7 above). We believe that the lack of a centerline, the approaching curve, and the close placements of the cushions before and after the curve would deter drivers from speeding up through the curve.




We recommend testing this strategy first at the LSD adjacent to the boardwalk with the sharpest curve (curve 5 in Table 5). This represents the most conservative test of the strategy which, if successful, could provide adequate evidence of the effectiveness of the strategy elsewhere.

The pilot would involve speed cushions placed temporarily in the manner described, while prevailing speeds are measured over a one week period. If the pilot is successful and the LSD resolved, then similar measures can be taken at the other two LSDs, and speed studies conducted at each. If the LSD is resolved at all three sites, designers can then move to the next phase; exploring whether other traffic calming measures are needed in between these sections to maintain speed reductions (see below). If the pilot fails to reduce speed adequately to resolve the LSD, additional traffic calming measures could be added (e.g., a third pair of speed cushions at each end).

If the speed reductions are insufficient to eliminate the LSD, designers might consider combining traffic calming with other changes that offer opportunities to resolve superelevation, discussed below. Consider the proposed modifications to embankments at the two LSDs (at curves 1 and 2, and again at curve 7) to eliminate the LSD. If the modifications include not only shaving the embankments but shifting the roadway up to 5' to the east, the modification could not only resolve the LSD but allow either the superelevation to be reduced and/ or a short section of 4' wide paved path to be included for wheelchair users on the west side of the road to bypass the curve. In a worse case scenario, the designers could also retain the boardwalk to bypass the LSD entirely.

*Reducing prevailing speeds to less than than 30 mph*

Our proposal for addressing overall prevailing speeds is based on the incremental approach to traffic calming originally referenced in our June 2021 proposal. This strategy involves adding traffic calming until the desired speed is reached. It begins by assessing whether targeted traffic calming helps to reduce speeds elsewhere on the road. Given the results of the October 2021 traffic study on the two way one lane section, it appears likely that other measures will be needed because drivers were noted to speed up between two sections with calming.

There are several considerations regarding any additional traffic calming needed.

- Designers could simply add speed cushions in between the LSDs. This is the simplest and most cost-effective option to implement, the option most readily understood by drivers, and an option that can be easily piloted.
- With pedestrians and cyclists sharing the roadway, designers could only add a short choker or a longer two way one lane section for motor vehicles if a sidepath is added for pedestrians.

Note the the elimination of LSDs and the reduction of prevailing speeds to 30 mph are sufficient to render Chandler Mill comfortable to cyclists of all ages and abilities.

*Cross-grades*

Our proposal includes reducing cross-slopes to 2% or less. This is necessary to make the roadway itself safe and comfortable for pedestrians of all ages and abilities, including wheelchair users. When we raised the potential of limiting superelevation with engineers, they raised objections with respect to safety and cost. We address each in turn

Some context is needed to understand concerns about safety. Given the engineer's recommendation of a design speed of 35 mph, any new construction involving curves on low-speed roads must consider superelevation (up to but not exceeding 4%) on any curves with a radius less than 510'. The engineers identified 9 such curves on the road, 8 of which exceeded superelevations greater than 2% (see Table 5 below). The standard of 510' for superelevation is taken from Table 3-13 in the AASHTO "Green Book" (see value outlined in red below).

- The first option for improving superelevation is simply to eliminate the crown and have the entire roadway sloped at 2%. Even assuming a design speed of 35 mph, this eliminates the need for superelevations greater than 2% on roadways with a radius greater than 408 feet. Only three curves (with radii of 170, 235, and 310') do not meet this standard (see value outlined in green in Table 3-13 adapted from the AASHTO "Green Book")

Table 3-13. Minimum Radii and Superelevation for Low-Speed Streets in Urban Areas

| U.S. Customary | | | | | | | |
|---|---|---|---|---|---|---|---|
| $e$ (%) | $V_d$ = 15 mph | $V_d$ = 20 mph | $V_d$ = 25 mph | $V_d$ = 30 mph | $V_d$ = 35 mph | $V_d$ = 40 mph | $V_d$ = 45 mph |
| | $R$ (ft) | $R$ (ft) | $R$ (ft) | $R$ (ft) | $R$ (ft) | $R$ (ft) | $R$ (ft) |
| −2.0 | 50 | 107 | 198 | 333 | 510 | 762 | 1039 |
| −1.5 | 49 | 105 | 194 | 324 | 495 | 736 | 1000 |
| 0 | 47 | 99 | 181 | 300 | 454 | 667 | 900 |
| 1.5 | 45 | 94 | 170 | 279 | 419 | 610 | 818 |
| 2.0 | 44 | 92 | 167 | 273 | 408 | 593 | 794 |
| 2.2 | 44 | 91 | 165 | 270 | 404 | 586 | 785 |

- The second option is to reduce the speed at the curve to 25 mph, either with targeted traffic calming, or as part of an overall recommendation to reduce the design speed to 25 mph (see below). A speed of 30 mph would eliminate the need for superelevations on curves with a radius of 270 feet (e.g., one of the three remaining curves), while a speed of 25 mph would eliminate the need for superelevations on curves with a radius greater than 167 feet (see value outlined in blue in Table 3-13 above) - or for all of the remaining curves.

When we raised the potential of reducing superelevations with engineers, they also raised concerns regarding cost. We expect that corrections involving excessive superelevations up to 6% can be remedied through repaving (4 of the 8 curves identified). Some additional work might be required to reduce superelevations on the remaining 4 curves. While this does entail some repaving and potentially other reconstruction costs, these are minimal compared to the fiscal and environmental cost of the current plan, especially given that repaving is already planned.

It may also be possible to resolve some of the superelevation through proposed modifications to embankments at the two LSDs described above. If the modifications

include not only shaving the embankments but shifting the roadway up to 5’ to the east, the modification could not only resolve the LSD but allow either the superelevation to be reduced and/ or a short section of 4’ wide paved path to be included for wheelchair users on the west side of the road to bypass the curve.

In a worse case scenario, the designers could also retain the boardwalk to bypass the LSD entirely. In this scenario, the width of the boardwalk could be reduced from 9’ to 5’, because it only needs to accommodate pedestrians.

***Learn more at www.kennettoutdoors.org/kennett-greenways***