USAID FAMILY FARMING PROGRAM FOR TAJIKISTAN

DESIGN OF A FLOW MONITORING SYSTEM FOR WUAs OF LOWER KOFARNIHON BASIN

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DESIGN OF A FLOW MONITORING SYSEM FOR WUAS OF THE LOWER KOFARNIHN BASIN

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ABBREVIATIONS

ADLE	Agriculture Development Livestock Enhancement
AO	Association Organizers
DAI	Development Alternatives Inc.
FTF	Feed the Future
FFP	Family Farming Program
GIS	Geographic Information System
IWM	Irrigation Water Management
MEWR	Ministry of Energy and Water Resources
STTA	Short Term Technical Advisor
ToT	Training of Trainers
USAID	United States Agency for International Development
USAID/CAR/T	United States Agency for International Development/Central Asian Republics/Tajikistan
WB	World Bank
WUA	Water Users Association
WUASP	Water Users Association Support Project (USAID funded, implemented by Winrock Intl., 2004-2011)

EXECUTIVE SUMMARY

The Family Farming Program (FFP) supported the creation and strengthening 60 Water User Association (WUA) in the Khatlon Province, including the lower Kofarnihon sub basin. These associations are now responsible for water fee collection for the newly created Agency for Land Maintenance and Irrigation. But accurate measurement of water delivered is currently not made in most parts of the region. Neither the water users or providers can know with certainty if the amount provided is more or less than estimated from standardize crop water consumption tables. This prevents the proper signaling of over or under paying (consuming) of an essential natural resource.

This guide provides site specific information on structure conditions, location and flow measurement methodology to allow all WUA to determine their net water consumption. The organization of units of water use, Water User Associations, provides an efficient level of water measurement that is in the interest of both farmers and delivery agencies. This system can be a scalable pilot program of national importance. The USAID family farming program thanks all the individuals for their contribution of information, to this pilot plan.

Introduction

Since 2006, under USAID support, several WUAs have been formed in the districts of Qubodiyon, Shahrituz and Nosirikhisrav of Khatlon Province, Tajikistan. The main source of irrigation water to these WUAs is Kofarinhon River. At the time of formation of WUAs, the main rehabilitation works that were undertaken were cleaning of some drains and construction of gates (within WUA territories as well as the head regulators of the distributary canals). Cleaning of drains and construction of gates has helped in improved regulation of water within WUAs, and increased the area under cultivation/irrigation within WUAs. However, the drainage problems still exist, and in some cases the waterlogged area within some WUAs is increasing gradually. There is no information on equity in water distribution within WUAs and among WUAs. There seems to be water scarcity towards the tail-ends of some irrigation canals. In some WUAs, drainage water from one WUA becomes irrigation water in the other WUA. Today, there is no information on how much water (in m^3/ha) a particular WUA has used per season, per month or per decade, and whether the water distribution among the WUAs is equitable or not. It clearly shows the need for improved water management. Improved water management is required at all three levels: on-farm level (on dekhan farms), WUA level (on-farm distribution canals), and main canal level.

Today, there are 27 registered WUAs in the Lower Kofarinhon River basin, consisting of the Rayons of Qubodiyon, Shahrituz and Nosiri khisrav. These WUAs receive water through a complex network of 11 canals (6 canals on the right bank and 5 canals on the left bank of the River) out of which 10 canals directly take water from the River. Most of these canals have hydroposts at the beginning of the canal. These hydroposts were constructed more than 40 years ago. The accuracy of these hydroposts is questionable because of sedimentation issues as well as changes in the channel sections and flow conditions in the channel. Because of lack of flow measurement structures along these main canals, there is no way to know the amount of water delivered to any particular WUA. Considering this, the farmers are charged for water at a flat rate of 10,000 m^3/ha for cotton, which is the most dominant crop that is grown in this region. However, the farmers think that they are applying significantly less than 10,000 m^3/ha, and are reluctant to pay the water charges. And, it is very difficult for the Raivodhozes to deal with thousands of farmers to collect irrigation water charges. Instead, it would be much more convenient for the Raivodhozes to deal with individual WUAs rather than thousands of individual farmers within WUAs. In view of this, it is proposed to measure the amount of water delivered to each WUA, and collect the irrigation water charges directly from the WUA based upon the volume of water delivered to each WUA.

Installation of flow measurement structures in the water distribution network would facilitate improved water management at the main canal level. This is an essential step in improving irrigation water management in irrigation schemes. The FFP project, which is funded by USAID, has initiated this idea, and the Ministry of Energy and Water Resources, and the Agency for Land Maintenance and Irrigation, (ALMI)ALMI) has completely endorsed this idea, and requested the FFP project to develop a detailed plan for a flow monitoring system for WUAs of the Lower Kofarnihon River Basin of Tajikistan. The ALMI is interested in implementing this plan as a pilot project by securing funding from a donor such as the World Bank, the Asian Development Bank, etc.

Location of Flow Measurement Sites

All the WUAs are formed along the main canals. Typically, these WUAs have 10 to 50 outlets to take water from the main canals. Most of the outlets are gravity fed, but some secondary canals (on-farm canals) pump water from main canals. At present, it is too expensive for the WUAs to put a flow measurement structure at each of the outlets in order to calculate the total volume of water supplied to a WUA. Therefore, it was decided to put the flow measurement structures only in the main canals to calculate the amount of water delivered to each WUA. Since the outlets of each WUA are located along a certain section of a main canal, it was decided to put flow measurement structures at the beginning and end of the main canal section of each WUA. In some WUAs, drainage water of one WUA becomes irrigation water for the downstream WUA. Flow measurement structures are proposed at such locations for proper water balance for the affected WUAs. In general, the following guidelines were followed in selecting locations for installation of flow measurement structures:

1. Selected channel section must be straight
2. No flow measurement structure was proposed in the immediate vicinity of a gate in the canal
3. Accessibility to the structure for reading staff gauge was considered
4. Locations were selected as close as possible to the boundary between two WUAs
5. If drainage water from a WUA returns to the River, no measurement structure was proposed

The proposed locations for installation of flow measurement structures are shown in Figure 1. At each proposed location, information on the shape and size (channel bottom width, channel top width, channel side slope, and channel depth) of the channel section were measured, where possible. However, information on the channel bottom slope and the expected maximum flow rate through the canal section were obtained from the WUA hydrotechnicians, and in some places estimated based upon my experience. Before construction, these values must be verified! The description of each site is presented below.

Flow Measurement Stations in Qubodiyon Rayon

Station #1: *Measurement Structure at Beginning of Kabla Canal*

There is a hydropost at the beginning of the Kabla canal, and it is decent condition. However, it was not decided to put a new measurement structure at this location, but clean the sediment and recalibrate the hydropost. [bottom width 10 m, top width 17.8 m, and the sloping side length is 4.8 m, the channel bottom slope is ~ 0.0003, and Q_{max} is 30 m^3/s]

Station #2: *Flood Flow Escape Structure on Kabla Canal*

This structure has two vertical sliding gates that are functional. However, there is some leakage from these gates, which is estimated to be between 2 to 3 m^3/s, and the canal can carry a discharge rate of about 10 m^3/s. This flow goes back to the river. During the non-flooding condition, this is a large quantity of water to be unaccounted for. Though, in the long run, these gates probably would be rehabilitated to minimize leakage and provide improved regulation, for the moment, for proper water balance, we plan to install a flow measurement structure in the concrete channel. [bottom width ~ 5 m, side slope m = 1, and Q_{max} is 3 m^3/s] There is a drop in the channel. It is an ideal location for flow measurement structure. Plan to put a broad-crested weir here.

Stations #3a and #3b: *Main Pumping Station of Faravon WUA*

This main pumping station supplies water to most of the WUA territory. In addition, there are 7 units that pump water directly from Kabla canal to irrigate their fields that are in the first tier. There are no flow meters at this pumping plant. It was decided to install two flow measurements structures here on Kabla canal: one before the pumping station, and one after the pumping station. Channel dimensions are as follows: [before the pumping station: channel bottom width 4 m, top width 11.6 m, and the length of sloping side is 5.7 m; after the pumping station: bottom width 5.1 m, top width 11.10 m, and the length of the sloping side over a horizontal distance of 2 m is 3.10 m, and canal bottom slope is 3 cm per 100 m ~ S = 0.0003]

Station #4: *Link canal from Kabla to Katta*

This canal takes water from Kabla canal to Katta canal. The discharge into the link canal is regulated using 3 vertical sliding gates. Only one gate is working decently, whereas the other two gates need major rehabilitation. The uncontrolled discharge was estimated to be between 3 to 4 m^3/s. For proper water balance to Kubod WUA, it was proposed to install a flow measurement structure in this link canal, just before the emergency channel (from Farovon WUA) joins the link canal.[channel bottom width 6.6 m; top width 16.8 m, and the sloping side length 6.6 m, Q_{max} is about 6 m^3/s, and channel slope~ 0.0005. Since there is lot of turbulence in the channel, the structure must be put at the far-end of the concrete channel]

Station #5: *Return flow from Farovon WUA*

Whenever farmers in Farovon are irrigating, there is some return flow from farmers' fields. In addition, whenever the power supply goes off, all the water from the pumps gets rejected. This large flow (may be up to 20 m^3/s) is diverted to an emergency canal. Flow from emergency canal joins the link canal, and flows into Katta canal. Therefore, we decided to put a flow measurement structure in the emergency channel. [channel bottom width 6.6 m, top width 14.6 m, and length of sloping side is 4.8 m, and approximate slope of the channel is 0.0004]

Station #6: *Point where Kabla canal enters Obi Hayot WUA territory*

At this point, we propose to measure the flow rate in the Kabla canal. This indicates the flow into Obi Hayot WUA as well as the outflow from Kubod WUA. This point is about 25 m to 30 m upstream of the first Obi Hayot WUA offtake from Kabla canal. [bottom width 4.4 m, top width 10.6 m, compound cross-section with a flow depth of 2.50 m, Q_{max} is 18 m^3/s , and channel slope of 0.0003, upstream top width 9.2 m]

Station #7: *Point where Kabla canal enters Takhti Sangin WUA territory*

This point is located few meters upstream of the drop structure that exists on Kabal canal, almost at the boundary between Obi Hayot and Takhti Sangin WUAs. Though the drop structure could have been used as an economical flow measurement structure, there is a big pump immediately upstream of the drop structure that supplies water to Takhti Sangin farmers. Therefore, a new location that is about 10 m upstream from the pump location was selected for installation of a new flow measurement structure. [bottom width 3 m, top width 9.6 m, canal depth 2.2 m, canal slope ~ 0.0003, and 8 m^3/s.]

Station #8: *Kabla canal leaves Takhti Sangin WUA/enters Jui Ravon WUA territory*

Jui Ravon WUA takes water from the last segment of Kabla canal, before Kabla joins Katta canal. We did not have time to visit this location where flow in Kabla leaves Takhti Sangin and enters Jui Ravon territory that is between Kabla canal and Katta canal. We plan to install a flow measurement structure at this point where Kabla starts to supply irrigation water to Jui Ravon WUA. The dimensions for the flow measurement structure are based upon some assumed channel geometry! [channel bottom width 0.5 m, flow depth 0.3 m, top width 0.6 m, and channel slope ~0.0003, and Q_{max} is ?] The geometry does not allow a flow measurement structure here. [I need to go to the site myself]

Station #9: *Beginning of Katta Canal*

During the Soviet-period, a regulating structure was constructed at the head of Katta Canal. This structure needs rehabilitation [needs gates], like everywhere else. A few meters downstream of this structure, there is a hydropost (a measurement structure), which is still being used. However, there is lot of sediment deposition, and the channel section is very irregular. This section needs to be rehabilitated. At this location, it is better to have a hydropost instead of a weir or flume. [channel width ~16 m, channel depth about 1.7 to 2 m]

Station #10: *Drainage flow from Kubod WUA flows under Katta Canal and joins Kofarnihon*

Drainage channel from Kubod WUA flows under Katta canal just upstream of the location on Katta canal where a flood discharge escape canal takes off (**Station #11**). For the moment, a flow measurement structure is proposed here. [Compound cross section: bottom width 2.5 m to a depth of 60 cm, second width (top width) of 7 m with an additional depth of 1.5 m, bottom slope 0.0002, and Q_{max} ~ 3 m^3/s]

Station #11: *Discharge into flood control canal*

Flood waters that enter Katta canal are discharged into Kofarnihon River in order to control flooding of several settlements that are adjacent to the canal. The head regulator of the flood control canal has two gates that are still functional, but excessive leakage takes place even when the gates are completely closed. The leakage was estimated to be not more than 3 m^3/s. Therefore, it was decided to design a flow measurement structure to measure the leakage from (through and around) the gates into the channel. The site for flow measurement structure is located about 40 to 50 meters from the head of the flood control canal. [channel width 8 m, flow depth 1.30 m, and slope ~0.0009, and Q_{max} = 14 m^3/s]

Station #12: *Drainage from Obi Hayot enters Katta canal*

Drainage water from Obi Hayot WUA has to go somewhere. I assume that this drainage water enters Katta canal somewhere. This needs to be verified. For the moment, no flow measurement structure is proposed here. Since the drains are not working properly, this amount may not be significant. It will be considered in the future.

Station #13: *Takhti Sangin WUA pumps water from Katta and discharges into Kabla canal*

Small pump lifts water from Katta canal, and carries this water to Kabla canal through a pipe. At this moment, no flow measurement structure is proposed to measure the pumped amount. In the future, a mechanism would be devised to estimate the discharge rate from the pump.

Station #14: *Takhti Sangin WUA pumps water from Katta and discharges into Kabla canal*

Small pump lifts water from Katta canal, and carries this water to Kabla canal through a pipe. At this moment, no flow measurement structure is proposed to measure the pumped amount. In the future, a mechanism would be devised to estimate the discharge rate from the pump.

Station #15: *Katta canal enters Nahri Kalon territory*

The proposed location for flow measurement structure is about 25 m to 30 m upstream of the distributary canal that divides the territory between Jui Ravon and Nahri Kalon. After this location, Jui Ravon WUA still continues to take water from the left bank of Katta canal (See Station # 8) until the point where Kabla canal joins Katta canal. [bottom width of channel 14 m, channel depth 2.5 m, bottom slope ~0.0003, and Q_{max} is 20 m^3/s]

Station #16: *Kabla canal joins Katta canal*

The size of Kabla canal when it joins Katta canal is very small (< 1.5 m^3/s). [bottom width 1.3 m, top width 2 m, channel depth 1.8 m, and channel slope 0.0003]

Station #17: *Katta canal enters Chirik WUA territory*

An old hydropost exists here. It is still in a decent working condition. Some minor repairs and re-calibration may be required to make the structure more accurate. There is good slope at this location with good freeboard. [channel bottom width 7 m, top width 12 m, channel depth 1.5 m, bottom slope ~ 0.0003, and Q_{max} is 12 m^3/s]

Station #18: *End of Chirik WUA/beginning of Avesta WUA on Katta canal*

There is an old hydropost here. Due to heavy sedimentation, and deformation of canal cross-section, the hydropost is not working properly. We propose to construct a broad-crested weir here. [channel bottom width 5 m, channel depth 1.7 m, bottom slope ~ 0.0003, and Q_{max} is 5 m^3/s]

Station #19: *Inflow into Chirik canal*

Chirik canal supplies water to Havascor WUA. This canal receives water directly from Kofarnihon River. Location for flow measurement structure was selected very close to the beginning of the canal, next to the WUA office. The canal has a mild slope with tranquil flow conditions. The location is about 50 meters downstream of the culvert under the main road. [channel width 6 m, depth 1.6 m, and bottom slope is ~ 0.0004, Q_{max} ~ 7 m^3/s]

Station #20: *Drainage from Jui Ravon to Lake Arik (Kul Arik)*

Drainage from Jui Ravon WUA flows into Lake Arik, and part of this water is diverted into a new canal that supplies water to Nahri Kalon. Lake Arik gets some water from the River directly. Part of the water from Lake Arik flows back to the River. [channel bottom width 4 m, top width 6 m, depth 1.5 m, and slope is about 0.0004, and Q_{max} = 5 m^3/s]

Station #21: *Beginning of Kul Arik Canal*

Lake Arik receives water directly from Kofarnihon and drainage outflow from Jui Ravon (see Station#20). Nahri Kalon WUA takes water from Lake Arik (where fish are raised) through Kul Arik canal. [channel bottom width 3 m, flow depth 1.3 m, channel bottom slope 0.0003, and Q_{max} is 2 m^3/s]

Station #22: *Small canal in Chirik WUA*

A small canal takes drainage water from Nahri Kalon and irrigates land in Chirik WUA. [channel width 3.5 m, and channel depth 1.2 m, bottom slope ~ 0.0003, and Q_{max} is 2 m^3/s]

Station #23: *Drainage channel (C-1) from Nahri Kalon enters Chirik WUA*

A collector drain (C-1) from Nahri Kalon flows into Chirik WUA, and supplies water to Hayot canal that starts in Chirik WUA. A flow measurement structure is proposed at the border between Nahri Kalon and Chirik WUAs (between two bridge crossings on C-1) for proper water balance for Nahri Kalon and Chirik WUAs. [channel width 6 m, channel depth 1 m, channel slope ~ 0.0002, and Q_{max} is 5 m^3/s]

Station #24: *Drainage flow in C-2*

A collector drain starts in Nahri Kalon and flows along Havascor and Nahri Kalon WUAs, and meets C-1 drainage canal. Part of the flow from C-1 and C-2 feed Hayot canal (a new canal that starts in Chirik WUA), and the rest of the drainage water goes into Kofarnihon River. [channel width 7 m, channel depth 1.3 m, channel slope ~ 0.0002, and Q_{max} is 10 m^3/s]

Station #25: *Beginning of Hayot canal*

As explained under Station #24, Hayot canal starts somewhere in the middle of Chirik WUA, and receives drainage water from C-1 and C-2, and some excess water from Katta canal. This water then flows all the way to WUA Fozilov and WUA Shoh. [channel bottom 7 m, channel depth 1.7 m, slope of canal ~ 0.00025, and Q_{max} is 8 m^3/s]

Station #26: *Drainage flow from Chirik WUA entering Kofarnihon River*

As mentioned under Station #24, all the drainage water collected by C-1 and C-2 is not diverted into Hayot canal. Whatever water that is not diverted into Hayot canal is carried back to Kofarnihon River by a single collector drain in Chirik WUA. [channel bottom width 9 m, channel depth 1.20 m, channel slope ~ 0.0001, and Q_{max} is 10 m^3/s]

Station #27: *Flow in Hayot canal at end of Chirik WUA*

Hayot canal starts in Chirik WUA, and after irrigating part of the land in Chirik WUA, leaves Chirik WUA, and provides irrigation water to two more WUAs downstream. This measurement structure is proposed at the end of Chirik WUA territory. [channel bottom width 4 m, top width 6 m, channel depth 1.6 m, channel slope ~ 0.0004, and Q_{max} is 8 m^3/s]

Station #28: *Beginning of Habib Fozilov WUA on Hayot canal*

The main source of water for Fozilov WUA is the Hayot canal. There are several drainage channels that discharge water back into Kofarnihon River. It was decided not to measure the drainage outflows from the WUA. [channel bottom width 6 m, channel depth 1.5 m, channel slope ~ 0.00035, and Q_{max} is 7.5 m^3/s]

Station #29: *End of Fozilov/beginning of Shoh WUA on Hayot canal*

Hayot canal provides irrigation water to Shoh WUA also. A flow measurement structure is proposed on Hayot canal at the boundary between Fozilov WUA and Shoh WUA. There is a hydropost here, but it is not in good condition. Therefore, a new measurement structure is proposed. The channel section seems to have been lined, but lot of sediment deposition was found on the lining. [channel bottom width 1.6 m, top width 5.7 m, channel depth 1 m, bottom slope ~ 0.00045, and Q_{max} is 3 m^3/s]

Station #30: *End of Chirik canal in Havascor WUA*

Chirik canal starts and ends in Havascor WUA. Unused water from Chirik canal flows into C-2 drain at the end of Havascor WUA. [channel width 2 m, channel depth 1 m, bottom slope ~ 0.0003, and Q_{max} is 3 m^3/s]

Flow Measurement Stations in Shahrituz and Nosirikhisrav Rayons

Station #31: Beginning of Tartki canal

Tartki canal takes water from Kofarnihon River. After 0.5 km from the beginning of the canal, there is a pumping station that is operated by Raivodhoz. The flow measurement structure is proposed about 0.5 km after the pumping station, just upstream of a bridge on

Tartki canal. All the water from Tartki canal goes to irrigate only the territory of Tartki WUA. At the end of the Tartki canal, drinking water is supplied to a village. A small amount of water is also supplied to Navruz WUA. [channel bottom 5.6 m, channel depth 1.35 m, channel slope ~ 0.0005, and Q_{max} is 5 m^3/s]

Station #32: Beginning of Big Beshkent Main Canal

This is a very big canal that takes water from Kofarnihon River. This canal is located just opposite of Kabla canal on the other side of the River. The canal was originally designed to carry a discharge rate of about 50 m^3/s, but today the maximum discharge is close to 25 m^3/s. There is a hydropost at the beginning of the canal, and it is in very good condition. However, the staff gauge and the channel bottom has sediment that needs to be cleaned for it to be accurate. No, new measurement structure is proposed at this site. This canal is very long, more than 40 km long, and provides irrigation water to Navruz WUA (1660 ha of area). At about 40 km, the canal bifurcates; the right branch continues as Big Beshkent canal, and the left branch continues as a flood escape channel (which is steep and lined). A small canal takes off from the right-side of the flood canal and is called the machinery canal and provides water to the tail portion of Navruz WUA.

Station #33: Beginning of right branch of Beshkent canal/end of Navruz territory

The right branch of Big Beshkent main canal provides water to several WUAs in Nosirikhisrav Rayon. Immediately after bifurcation, this canal does not provide any water to Navruz WUA. Therefore, it was decided to install a flow measurement structure at this location, which measures the discharge flowing out of Navruz WUA to other downstream WUAs on the canal. [channel bottom 3.6 m, top width 10.6 m, channel depth 3.5 m, channel slope~ 0.0003, and Q_{max} is about 15 m^3/s]

Station #34: End of flood escape canal (from Big Beshkent) joins Mali Beshkent canal

The flood escape canal from Big Beshkent main canal joins the Mali Beshkent canal. Navruz WUA does not release very much water into this canal because they think they do not have enough water for themselves. However, we decided to put a measurement structure here. [channel bottom width 2 m, top width 8 m, side slope m=1.5, channel slope ~ 0.0006, and Q_{max} = 8 m^3/s]

Station #35: Beginning of Khokak Canal

This canal takes water directly from Kofarnihon River, and provides water to some part of Qaroqul WUA. [channel bottom 2 m, depth 2 m, channel slope ~ 0.0005, and Q_{max} is 2.5 m^3/s]

Station #36: Beginning of Shahrituz canal

Shahrituz canal is the main source of water for Qaroqul WUA. It has a hydropost at the beginning of this canal. The hydropost is in decent condition, and requires minor repair work. The metallic walkway bridge at the hydropost requires some repair as well. [channel bottom width 7.3 m, top width 10.2 m, channel depth 2 m, and channel slope ~ 0.0002, and Q_{max} is 10 m^3/s]

Station #37: Beginning of small Shahrituz canal

This is a small canal next to the Shahrituz canal, and provides water to Qaroqul WUA. [channel width 2.5 m, channel depth 1.6 m, channel slope ~ 0.0003, and Q_{max} is 2 m^3/s]

Station #38: Beginning of Mali Beshkent canal

Mali Beshkent canal takes water from Shahrituz canal, and provides water to WUA Vatan-1. A flow measurement structure is proposed at the beginning, immediately upstream of a pump location, of Mali Beshkent canal. After this offtake, Shahrituz canal turns left and continues further, and enters the territory of Khojai Jom WUA. [bottom width 7.2 m, top width 9.30 m, channel depth 2 m, channel slope ~ 0.0003, and Q_{max} is 8 m^3/s]

Station #39: Shahrituz canal enters Khojai Jom WUA territory

Shahrituz canal is the main source of water for Khojai Jom WUA. This canal ends in Khojai Jom WUA. [channel width 6.8 m, depth 1.5 m, channel slope ~ 0.0003, and Q_{max} is 6 m^3/s]

Station #40: Beginning of Sayod canal

Sayod canal takes water directly from the River. There is a decent hydropost, but with sedimentation issues. Sayod WUA is a large WUA with an area of 4000 ha, and Sayod canal is the main source of irrigation water to the WUA. It was decided to repair and use the hydropost as the flow measurement structure. [Q_{max} is 15 m^3/s]

Station #41: Junction of drainage channel from Khojai Jom WUA and Sayod canal

A small drainage channel from Khojai Jom WUA joins Sayod canal. [channel width 1 m (channel width at structure is 1.4 m), channel depth 0.85 m, channel slope ~ 0.0002, and Q_{max} is 1.5 m^3/s]. The channel hydraulics does not allow the discharge rate to be more than 0.5 m^3/s. Hencce, no flow measurement structure is proposed now.

Station #42: Junction of drainage channel from Sayod WUA and Khushodi canal

A collector drain from Sayod WUA joins Khushodi canal and supplements irrigation water supply to Khushodi canal which supplies water to 4 to 5 WUAs. [channel width 4 m, depth 2 m, slope ~ 0.0002 and Q_{max} is 4 m^3/s]

Station #43: Beginning of Khushodi canal

Khushodi canal takes water from Kofarnihon River. This is the last canal on the River in Shahrituz province. This canal supplies water to 4 or 5 WUAs that were formed under WUASP. We did not have any information on the WUA boundaries, and WUA names. Once the WUA boundaries are identified, we would construct additional measurement stations on this canal. [Channel width 10 m, channel depth 2 m, channel slope ~ 0.0002, and Q_{max} is 9 m^3/s]

Station #44: Mali Beshkent canal enters Beshkent WUA

Mali Beshkent canal supplies water to Beshkent WUA. This is the last WUA on this canal. [channel bottom width 4.7 m, top width 6.6 m, depth 1.2 m, bottom slope ~ 0.0005, and Q_{max} is 5 m^3/s]

Station #45: Drainage canal entering Beshkent WUA territory

A drainage canal that collects water from some WUAs in Nosirikhisrav Rayon enters Beshkent WUA. This water is used for irrigation in Beshkent WUA. [channel bottom width 5 m, top width 10.6 m, channel depth 2.5 m, slope ~0.0001, and Q_{max} is 6 m^3/s]

Station #46: On Chasma canal

Chasma canal gets water from springs in the mountains, and provides irrigation water to WUA Chasma. [channel bottom 6.5 m, top width 9.5 m, channel depth 2.5 m, bottom slope ~ 0.0004, and Q_{max} is 20 m^3/s (?)]

Station #47: Beginning of VBK-3

VBK-3 is a branch canal that takes off from Big Beshkent canal. Remember, Big Beshkent canal takes water from Kofarnihon River, and after providing irrigation water to Navruz WUA in Shahrituz Rayon, it continues into Nosirikhisrav Rayon, and provides water to 4 WUAs here. VBK-3 provides water to WUA Sayhun [channel bottom width 2.5 m, top width 5.6 m, channel depth 1.4 m, bottom slope ~ 0.0004, and Q_{max} is 2.5 m^3/s]

Station #48: Beginning of VBK-4

VBK-4 takes off from Big Beshkent canal, and provides irrigation water to Vodi Beshkent WUA. [channel bottom width 2.2 m, top width 8.6 m, channel depth 2 m, bottom slope ~ 0.0002, and Q_{max} is 3 m^3/s]

Station #49: Beginning of VBK-5

VBK-5 takes off from Big Beshkent canal (at the end), and provides irrigation water to WUA Korvon. [channel bottom 3.2 m, top width 9 m, and channel depth 1.5 m, bottom slope ~ 0.0003, and Q_{max} is 5 m^3/s]

Station #50: Beginning of VBK-6

VBK-6 takes off from Big Beshkent canal (at the end), and provides irrigation water to Vodi Beshkent WUA. [channel bottom 1.1 m, top width 7 m, and channel depth 1.6 m, bottom slope ~ 0.0005, and Q_{max} is 4 m^3/s]

Station #51: Beginning of VBK-7

VBK-7 takes off from Big Beshkent canal, and provides irrigation water to Sayhun WUA. [channel bottom 3.7 m, top width 6.8 m, and channel depth 1.5 m, bottom slope ~ 0.0005, and Q_{max} is 5 m^3/s]

Station #52: End of Khusodi- Beginning of Dusti WUA

This station is located at the border between Khusodi WUA and Dusti WUA. The channel dimensions are as follows: bottom width = 7 m, top width = 7 m, delpth = 2.5 m, bottom slope ~ 0.0005, and Q_{max} = 5 m^3/s.

Station #53: A branch canal of Khusodi supplying water to WUA Orzu

A branch canal starts from Khusodi canal and supplies water to WUA Orzu. This location is on this branch canal at the border between WUAs Dusti and Orzu. The channel dimensions are as follows: bottom width = 2.8 m, top width = 3 m, depth = 1 m, bottom slope ~ 0.00018, and Q_{max} = 1 m^3/s.

Station #54: Beginning of Orzu WUA on Khusodi canal

This Station is located on Khusodi canal, at the border between WUAs Dusti and Orzu. The channel dimensions are as follows: channel bottom width = 5 m, channel top width = 7 m, channel depth = 1.9 m, channel bottom slope ~ 0.0003 and Q_{max} = 4 m^3/s.

Station #55: Beginning of Aivoj WUA on Khusodi canal

This is the last WUA on Khusodi canal. The channel geometry parameters are as follows: bottom width = 5 m, top width = 7 m, channel depth 1.3 m, and channel bottom slope ~ 0.0002, and Q_{max} = 2 m^3/s.

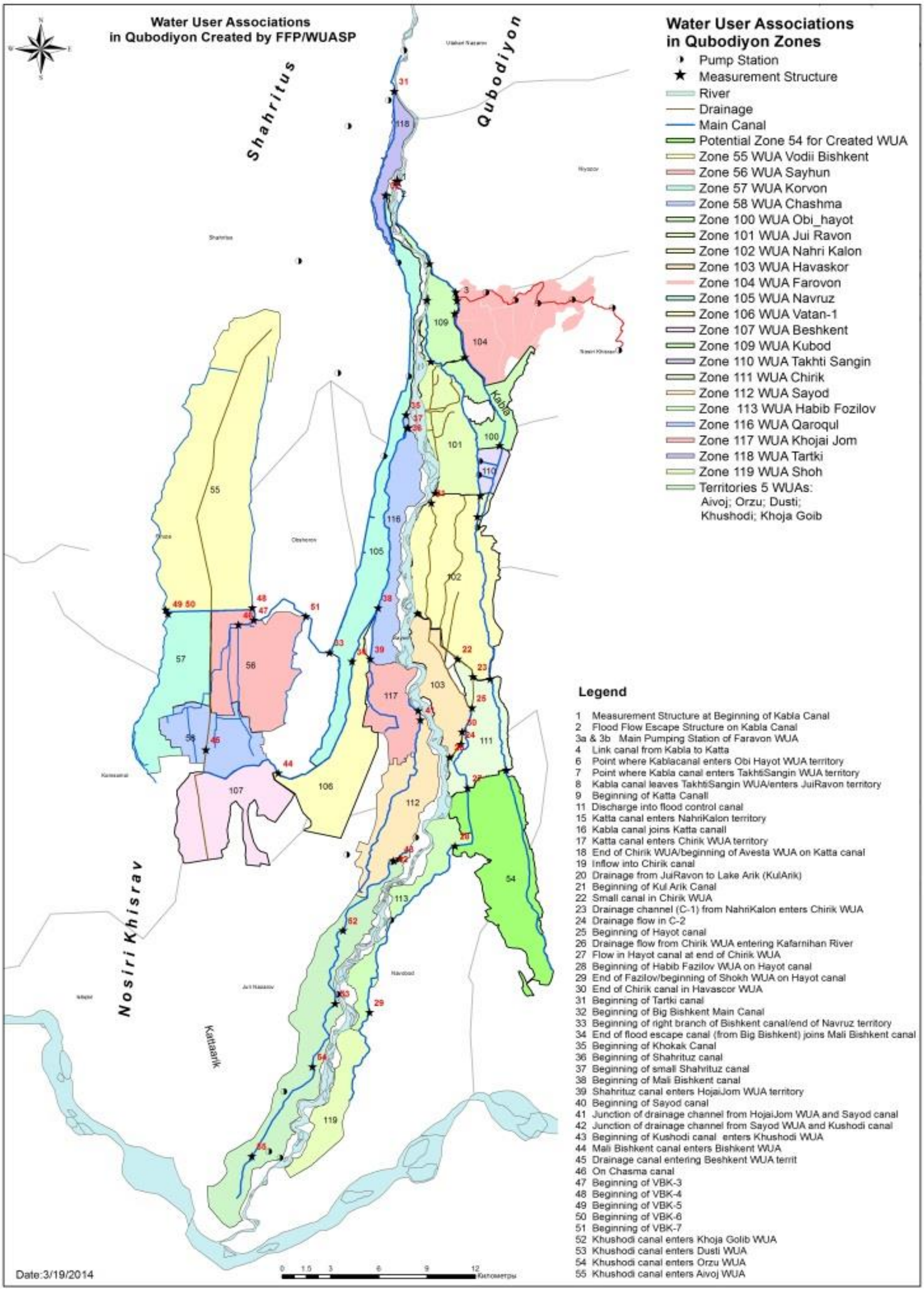


Figure 1. Location of Flow Measurement Structures on the Canal Network in the Lower Kofarnihon Basin

Design and Construction of Flow Measurement Structures

Only two types of flow measurement structures are proposed for construction in this irrigation scheme: traditional hydroposts, and broad-crested weirs (BCWs) or longthroated flumes (LTFs). In several locations along Kabla and Katta canals, we identified hydroposts. Some of them are in decent condition requiring some repair, whereas others need major rehabilitation to make these hydroposts functional. All the hydroposts that require minimal repair would be repaired and retained as a flow measurement structure. The hydropost locations that require a major canal rehab work would be replaced by a BCW or a LTF. The size and shape of the BCW or LTF would be configured based upon the site specific requirements. In some places along the canals, we found some lined canal sections, which are typically of trapezoidal shape. Therefore, all the flow meters proposed in lined channel sections are trapezoidal in shape. And, the flow measurement structures proposed in earthen channels are all rectangular in shape. These structures, once constructed are expected to last for next 25 to 30 years with minimal maintenance. The only information that a mirob is supposed to collect is the vertical gauge reading which measures the flow depth with respect to the elevation of the weir crest or the reference elevation of the hydropost. For each flow measurement structure, a gauge reading-discharge graph and an equation for calculating discharge rate would be developed, and these equations will be used in an excel spreadsheet. Flow measurement structures in an earthen canal and a lined canal are shown above.

The proposed flow measurement structures were designed using the **WinFlume** software developed by the United States Department of Agriculture (USDA), the International Institute for Land Reclamation and Improvement (ILRI, Netherlands), and the United States Bureau of Reclamation (USBR). Detailed design specifications, and estimated cost of construction for each flow measurement structure are provided in Appendix-1 and Appendix 2. A total of 55 locations were identified for installation of flow measurement structures. However, after careful evaluation, it was decided not to install any flow measurement structures at the following 10 locations: Station#10, Station#12, Station#13, Station#14, Station#20, Station#23, Station#24, Station#26, Station#30, and Station#41. Most of these points are on drainage channels, and are not very important for volume-balance calculations at this time!

Typically, these flow measurement structures are constructed using concrete (a mixture of cement, sand and gravel). The cost of construction of these structures depends upon the volume of concrete required or the number of precast concrete blocks required. Based upon the information obtained from the FFP project engineer, the cost per one cubic meter of concrete was estimated to be approximately $225. This cost includes the cost of labor to clean and excavate the canal at the site of construction, cost of cement, sand and gravel, wood required for the forms, steel rebar, transportation cost for the materials, labor cost for constructing wooden forms, mixing concrete, pouring concrete into the forms, and labor for earthwork in backfilling around the flume. If available, flow measurement structures can also be built using precast concrete blocks, as shown above. The cost of constructing rectangular flumes using these concrete blocks would be cheaper than using concrete. These concrete blocks are available in Tajikistan. At each flow measurement site a vertical staff gauge also needs to be installed.

The size of the flow measurement structure required at any given location depends upon the maximum expected flow rate through the given section, and the type of channel material, i.e. whether it is a concrete lined channel section or an earthen channel section. The cost of constructing a flow measurement structure in a lined channel section is much cheaper than constructing the same flow measurement structure in an earthen channel! The flow rates to be measured in the irrigation canals here range from 2 m^3/s (2,000 ℓps) to 30 m^3/s (30,000 ℓps). The estimated volume of concrete required and the cost of construction of each proposed flow measurement structure is presented in Appendix-2. A total of 46 flow measurement structures are proposed in the irrigation canals that supply water to 27 WUAs. Out of the 46 flow measurement structures, only in 3 or 4 locations, it was proposed to use the existing hydroposts (after some repair work is done!). The total estimated cost of construction of these 46 flow measurement structures is approximately $179,163 where the estimated cost of construction of individual flow measurement structures ranged from $621 (at Station#47, in a trapezoidal canal with a design discharge rate of 2.5 m^3/s) to $10,706 (at Station#6, in an earthen channel with a design discharge rate of 20 m^3/s). In the case of a trapezoidal shaped flow measurement structure in lined channels, the volume of concrete required is calculated based upon the volume of concrete required to build the weir crest and the upstream ramp. It may be possible to use a combination of concrete blocks and concrete in constructing flow measurement structures in trapezoidal channels. In the case of a rectangular shaped flow measurement structure in earthen canals, the volume of concrete required to build is estimated based upon the volume required to build the weir crest, the two parallel sidewalls of the weir, and the upstream and downstream face walls of the weir. The thickness of the walls is set at 0.20 m, and the height of the walls is set equal to the flow depth in the channel + 0.30 m of foundation below the channel bottom + 0.50 m of freeboard above the water level (at Q_{max}) in the channel. It is possible to build each of the rectangular flumes with only concrete blocks. Gravel riprap is recommended downstream of weir to avoid channel erosion.

As mentioned before, *the design specifications for the flow measurement structures are based upon estimated channel bottom slopes. At the time of construction of these structures, it is strongly recommended to gather information on the actual slope of the channel section at the proposed locations, and adjust the flume dimensions accordingly.* Also, one has to be very careful in finding the actual bottom elevation of the channel. As you know, all the depths specified in the design are with respect to the channel bottom. Since channel bottoms are typically irregular in shape, one has to be very careful in estimating the real channel bottom. If the channel bottom is not correctly estimated, the flow measurement structure might be set a bit higher or lower than what is required. If it is set higher, sometimes, it might cause bank overflow upstream of the structure, and if the flume is set lower than the specified elevation, the structure may be operating under submerged conditions, and introduce error into calculation of flow rates! The design specifications for all the flow measurement structures are provided in **Appendx-1**. At the time of construction of these flumes, a consultant with familiarity with design and construction of these flumes must be present to supervise it. Otherwise, the flumes may be constructed incorrectly, and may not function as designed!

The ideal time for construction of the flow measurement structures between October (after plantation of Winter Wheat) and March (before the start of irrigation in Spring).

Data Collection and Transmission

All the proposed locations for the flow measurement structures are on the main/branch canals of the different irrigation schemes. As soon as the measurement structures are constructed, including the staff gauge at each flume, the structures are ready for flow monitoring.

Today, the hydroposts on main/branch canals are monitored by personnel from Raivodhozes. Therefore, it is expected that in the future the flow in the main/branch canals would be monitored by mirobs belonging to the Land Reclamation and Irrigation Agency (ALMI). It is suggested that all the mirobs of the Agency be provided with smart cell phones for data collection and transmission purposes. smart cell phones allow for a small software program to be loaded into the Cell Phones. This software program provides an interface for the mirobs to enter the staff gauge reading and send the information to a specified location (a specified computer that accepts SMS messages) automatically. smart cell phones also have the capacity to register the GPS location of the cell phone, and the loaded software program will be able to access this information automatically from the smart cell phone memory and send this information also automatically to a central location for processing. Information on the GPS location of the cell phone is used to automatically identify the Station# of the flow measurement structure. This way, the mirobs have to be physically present at the sites of the flow measurement structures to transmit the data to a centralized location. In other words, the mirobs will not be able to sit at home and make up the staff gauge data! Once the newly developed software program is loaded into the smart cell phones, all the mirobs will be trained on how to use the cell phone to transmit the data. At each measurement station, the following Protocol will be followed:

1. Gauge readings from all the flow measurement stations will be taken daily between 7 to 8 AM during the irrigation season. If two readings per day are required, another reading may be taken between 5 to 6 pm every day of the irrigation season.
2. Each measurement station should have a designated Agency mirob to collect and transmit the required data.
3. The collected data would be entered into a record book every day.
4. At each station, a designated mirob from each WUA also monitors the flow at flow measurement structures that are appropriate for their WUA. The measured readings should be recorded in a notebook as well. This data would be then entered into an Excel-based software for calculation of flow rates and volumes of water received by each WUA on a daily basis.

The cost of each smart telephone is estimated to be about $150. There are 46 flow measurement locations. Depending upon the distance between different flow measurement stations, one mirob may be able to cover more than one flow measurement structure, if the distance between any flow measurement structures is not very much. For the moment, we propose to purchase about 41 smart cell phones for this purpose. Therefore, the total cost of purchasing 41 cell phones is $6150. This is only an approximate cost.

5. DATA PROCESSING, DISSEMINATION AND DISPLAY

Most of the WUAs in this area are or were supported by FFP. All these WUAs have a computer, with Microsoft Office (Excel Spreadsheet, etc) software on it, I assume. I assume that the non-FFP project WUAs also have a computer. If not, they should be provided with a computer. Similarly, the Federation of WUAs also should acquire a computer. In addition, I recommend that the Provincial and District Level offices of ALMI also should be provided with a computer to monitor the flow data on a daily basis during the season.

Data Processing at WUA Level

During the irrigation season, the designated mirobs of each WUA will collect the staff gauge reading data from the flow measurement structures that are appropriate for the given WUA. The gauge readings are taken every day of the season (once or twice per day). This data will then be entered into an excel Spreadsheet software that will be installed on the WUAs computers after the flow measurement structures are constructed. This software basically calculates the volume of water received by the WUA on a daily basis, and computes the cumulative volume of water received by the WUA until the current date. This software will also display the daily flow rates received by the WUA graphically throughout the season. A sample copy of the proposed software is presented in Appendix-3. Development and installation of this software on all the WUAs computers would take about 2 to 3 weeks. This excel Spreadsheet software will be converted into Tajik language, and appropriate WUA staff (most likely the accountant and a young mirob of each WUA) would be trained to use this software.

Data from the flow measurement stations will be used as follows to calculate the volume of water delivered to each WUA up to the current date. Once the gauge readings data is entered into the computer, all the calculations will be automatically done by the excel software. The volume of water used by each WUA on a daily basis as well as cumulative volume received until the current date will be calculated using the following relationships (Refer to Figure 1 for location of Stations]

WUA Kubod = Volume of [Station#1 – Station#2 – Station#3a + Station#3b – Station#4 – Station#6]

WUA Farovon = Volume of [Station#3a – Station#3b - Station#5]

WUA Obi Hayot = Volume of [Station#6 – Station#7]

WUA Takhti Sangin= Volume of [Station#7 – Station#8]

WUA Jui Ravon = Volume of [Station#8 – Station#16 + Station#9– Station#15]

WUA Nahri Kalon= Volume of [Station#15 + Station#16 + Station#21 – Station#17 – Station#22 – Station#25]

WUA Chirik = Volume of [Station#17 + Station#22 + Station#25 – Station#18 – Station#27]

WUA Havascor = Volume of Station#19
WUA Avesta = Volume of Station#18

WUA Fozilov = Volume of [Station#28 – Station#29]

WUA Shoh = Volume of Station#29

WUA Tartki = Volume of Station#31

WUA Navruz = Volume of [Station#32 – Station#33 – Station#34]

WUA Qaroqul = Volume of [Station#35 + Station#36 + Station#37 – Station#38 – Station#39]

WUA Vatan-1 = Volume of [Station#38 – Station#44]

WUA Khojai Jom= Volume of [Station#39 – Station#41]

WUA Sayod = Volume of [Station#40 + Station#41 – Station#42]

WUA Beshkent = Volume of [Station#44 + Station#45]

WUA Chasma = Volume of Station#46

WUA Korvon = Volume of Station#49

WUA Sayhun = Volume of [Station#47 + Station#51]

WUA Vodi Beshkent=Volume of [Station#48 + Station#50]

WUA Khushodi = Volume of [Station#43 – Station#52]

WUA Khoja Golib= Volume of [Station#52 – Station#53]

WUA Dusti = Volume of [Station#53 – Station#54]

WUA Orzu = Volume of [Station#54 – Station#55]

WUA Aivoj = Volume of Station#55

Data Processing at the Lower Kofarnihon Sub-Basin Level

As mentioned earlier, all the data collected by the ALMI mirobs from the 46 flow measurement structures will be sent to a central location by SMS. This location can be either in Qubodiyon or Kurgan Teppa. We recommend that a dedicated computer server be purchased for this purpose. Also, because of the irregularity of the power supply, we suggest the installation of a UPS (**U**ninterrupted **P**ower **S**upply) back-up power unit.

A special software needs to be developed and loaded on this computer server in order to:

1. Receive the SMS messages from the 46 flow measurement structures once or twice a day
2. Process the data, and compute the volumes of water received by each WUA on a daily basis (using the flow equations developed for each flow measurement structure)
3. Calculate the volume of water delivered per hectare of irrigated area of each WUA
4. To display all this information on a Website so that anybody that has internet access can access all this information (OPTIONAL). A password can be setup in order to limit the access to ONLY authorized persons.

5. Send SMS messages, automatically, to the following personnel everyday between 9 am and 10 am:
    a. To all the Chairmen/Directors of WUAs
    b. To all Federations of WUAs for necessary actions for improving equity in water distribution
    c. To relevant ALMI officials in Qubodiyon, Shahrituz and Nosirikhisrav Rayons for record keeping, and adjusting flow rates into canals, if necessary
    d. To relevant ALMI officials in Kurgan Teppa and Dushanbe for information and necessary action.

The type of information received by each of the above 4 groups of people can be different. At the moment, the following information will be disseminated to different groups of people:

WUA Chairman/Director

1. The volume of water received by their WUA on a daily basis
2. The flow rate received on a daily basis
3. The current cumulative water charges owed to the Agency on a daily basis
4. The flow rates received by neighboring WUAs

Federation Chairman

1. The volume of water received by each of their WUAs on a daily basis
2. The flow rates received by each of their WUAs on a daily basis

ALMI Officials in Qubodiyon, Shahrituz and Nosirikhisrav

1. The flow rates received by the WUAs in their Rayon on a daily basis
2. The daily and cumulative volume of water received by each of their WUAs on a daily basis.
3. The cumulative water charges owed by each WUA in their Rayon

ALMI Officials in Kurgan Teppa and Dushanbe

1. The flow rate delivered into each of the 10 canals in the Sub-basin on a daily basis
2. The volume of water supplied to each of the 10 canals in the Sub-basin on a daily basis

To develop the above program, a software company in Dushanbe needs to be identified. If no such software company exists, there is a company called Sigma that is based in Bishkek that is capable of developing such a software program. Finally, I know of a company in Hyderabad, India, that already developed software for accomplishing the above tasks on an irrigated area of 8,000,000 hectares. I assume that the cost of developing such a software package might be around $40,000. I will get a better estimate of developing this software once a decision is made to implement the above program. Once this software is developed for this Sub-basin, duplicating this software for other sub-basins would be much cheaper!

Budget for Implementation

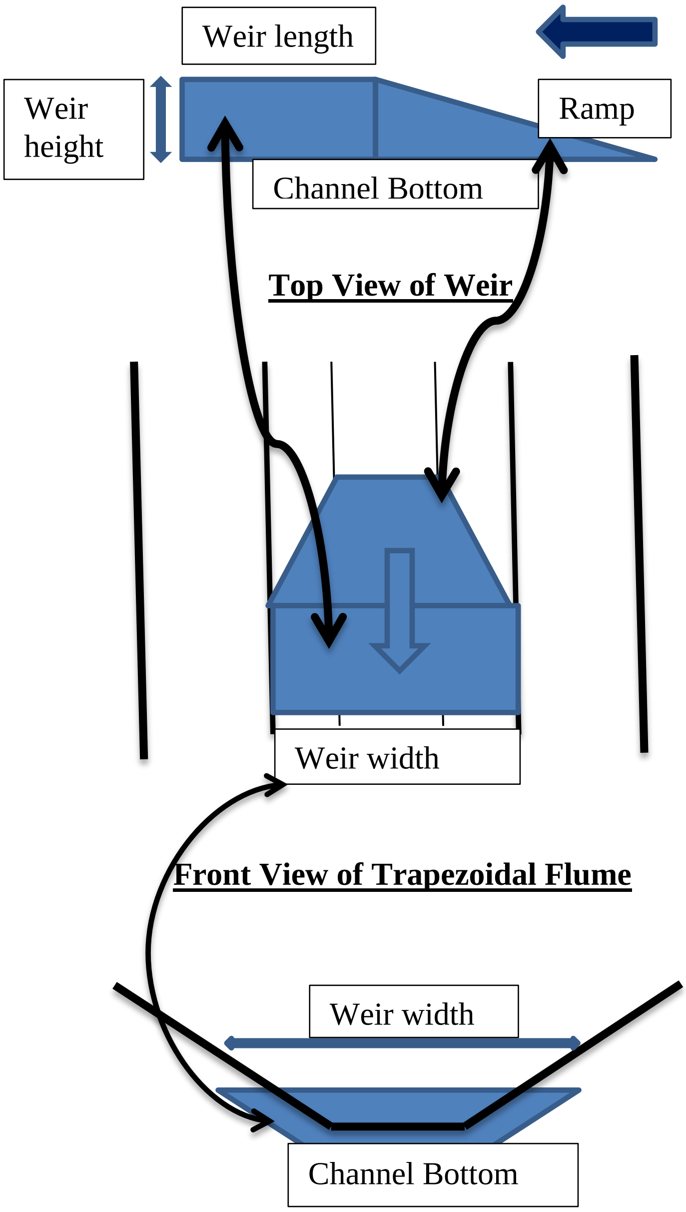
The estimated total cost for implementation of the proposed flow monitoring plan for the Lower Kofarnihon Basin is $290,313 which includes the cost of construction of 46 flow measurement structures, cost of 41 Smart Cell Phones, purchasing computer hardware (for 3 Rayon offices, and Provincial and Republic level offices), development of software package for SMS data processing, display and dissemination, and for international consultant to guide in the construction of flow measurement structures and the development of the above software. The itemized costs are presented in the table below:

Item#	Item	No. of items	Cost, $
1	Construction of flow measurement structures	46	179,163
2	Smart Cell Phones	41	6150
3	Software Development	1	40,000
4	Man-months of consultant's efforts	2	45,000
5	Computers and other hardware	-	20,000
6	**TOTAL**		**290,313**

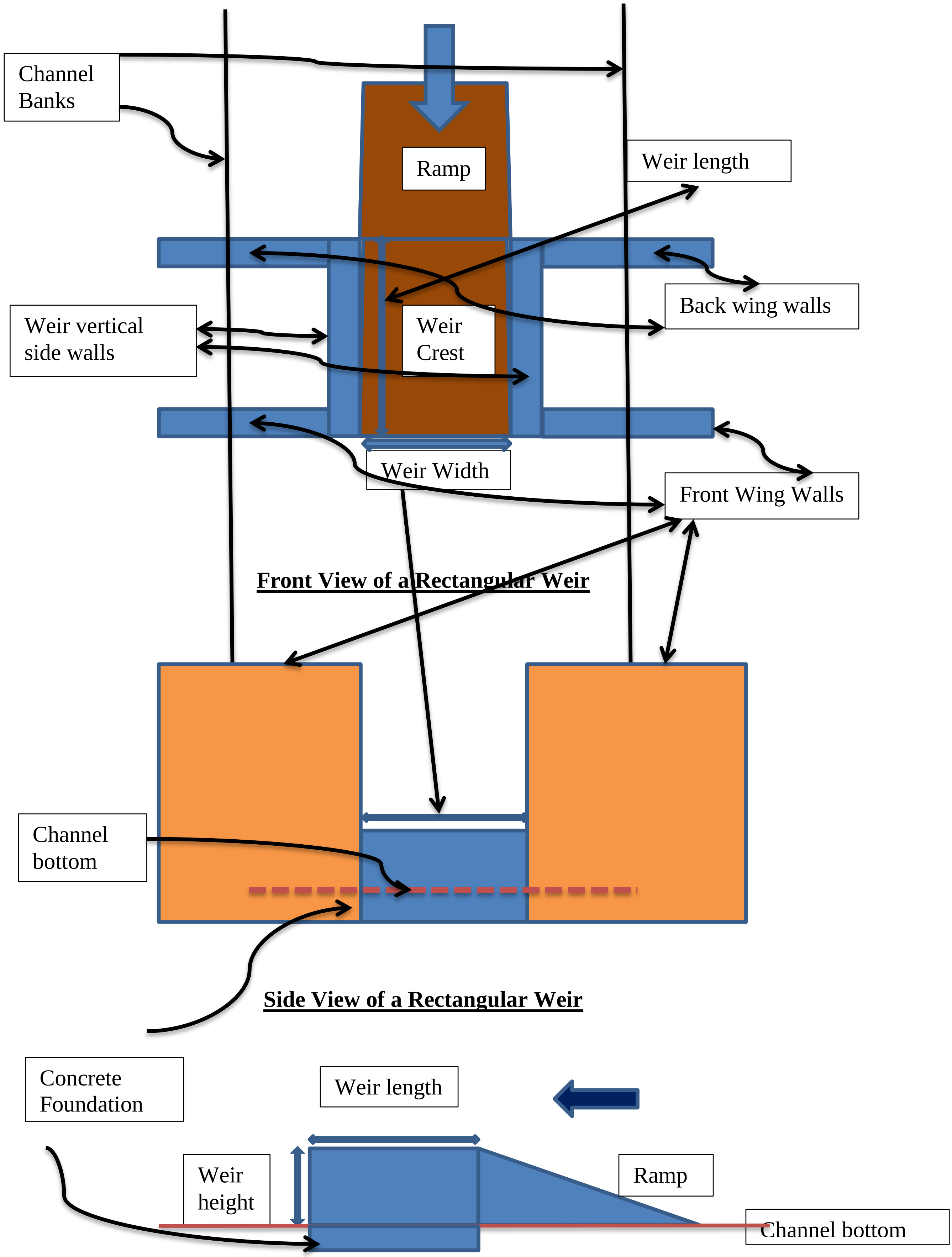
APPENDIX 1 DRAWINGS FOR FLOW MEASUREMENT STRUCTURES

There are close to 40 flume drawings that were generated by the WinFlume Program. These drawings could not be saved in a format that I could import into a word document. Hence, all these drawings have to be printed, scanned, and then attached as a PDF file to the main word document. I will submit these drawings later on. In the meantime, I have provided you the construction drawings for a Trapezoidal shaped flume, and a rectangular shaped flume.

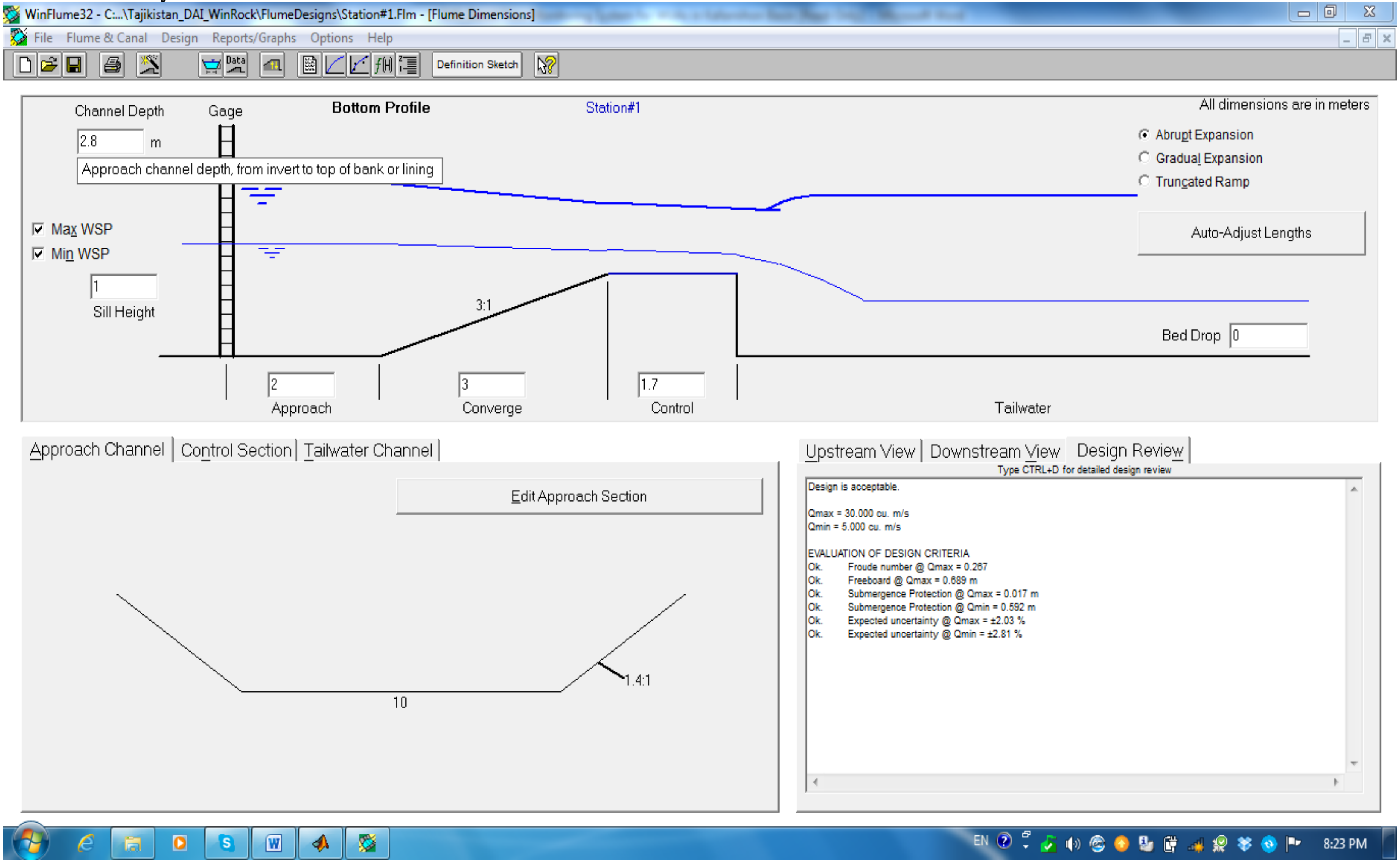
Side View of Trapezoidal Flume/Weir

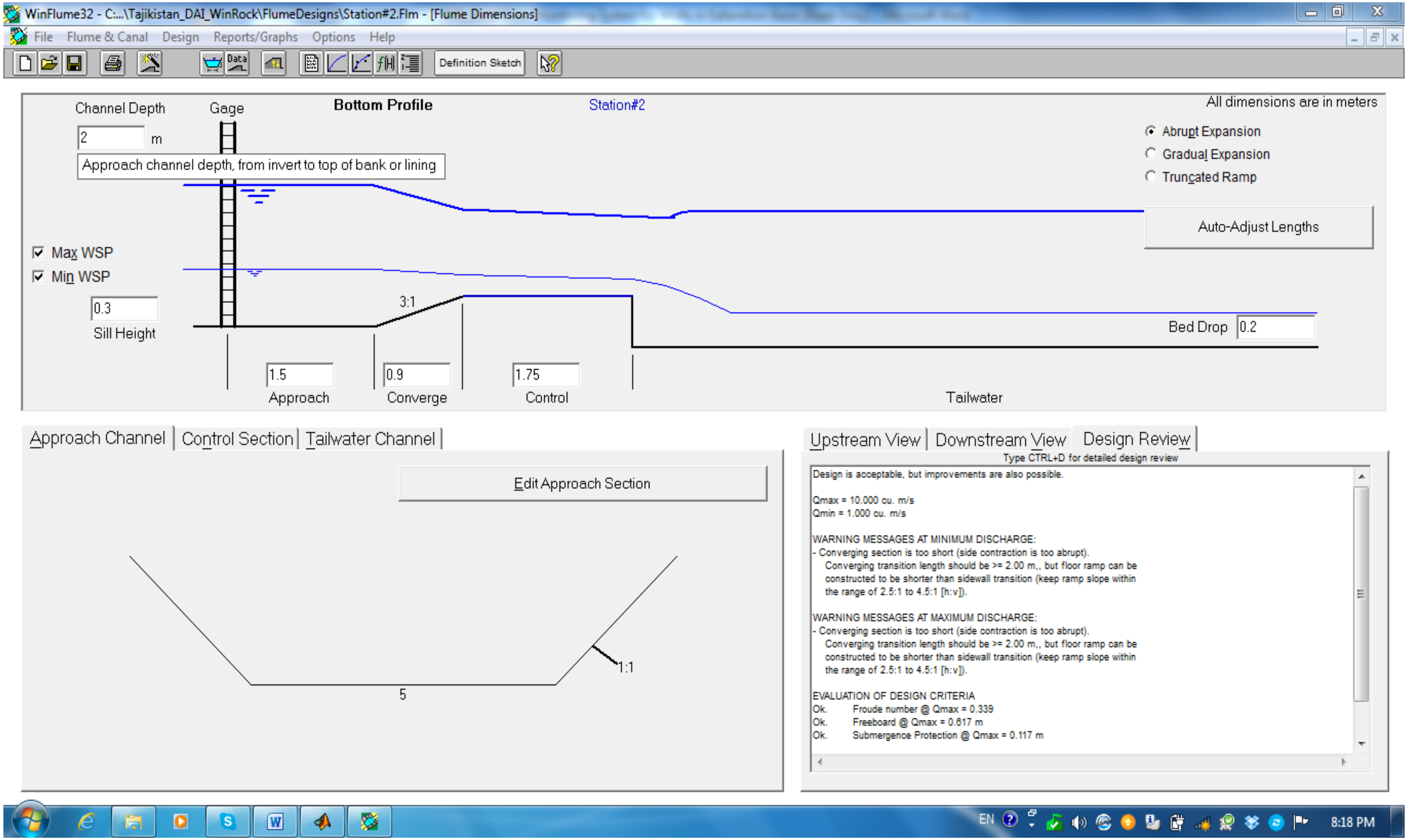


Top View of a Rectangular Weir



WinFlume Analaysis of Station Structures

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File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#2
All dimensions are in meters
2
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.3
Sill Height
3:1
Bed Drop
0.2
1.5
Approach
0.9
Converge
1.75
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1:1
5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 10.000 cu. m/s
Qmin = 1.000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.00 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.00 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
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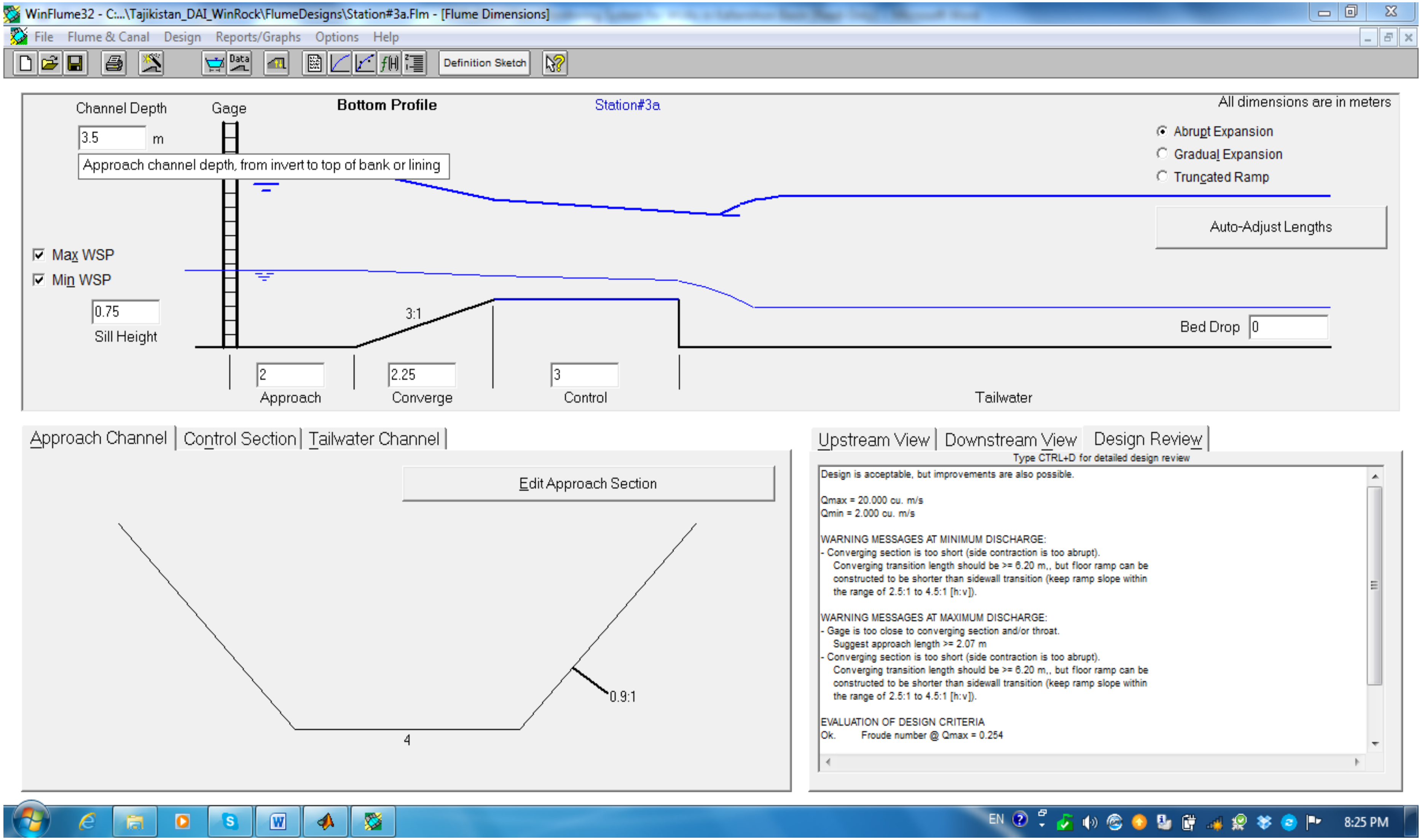
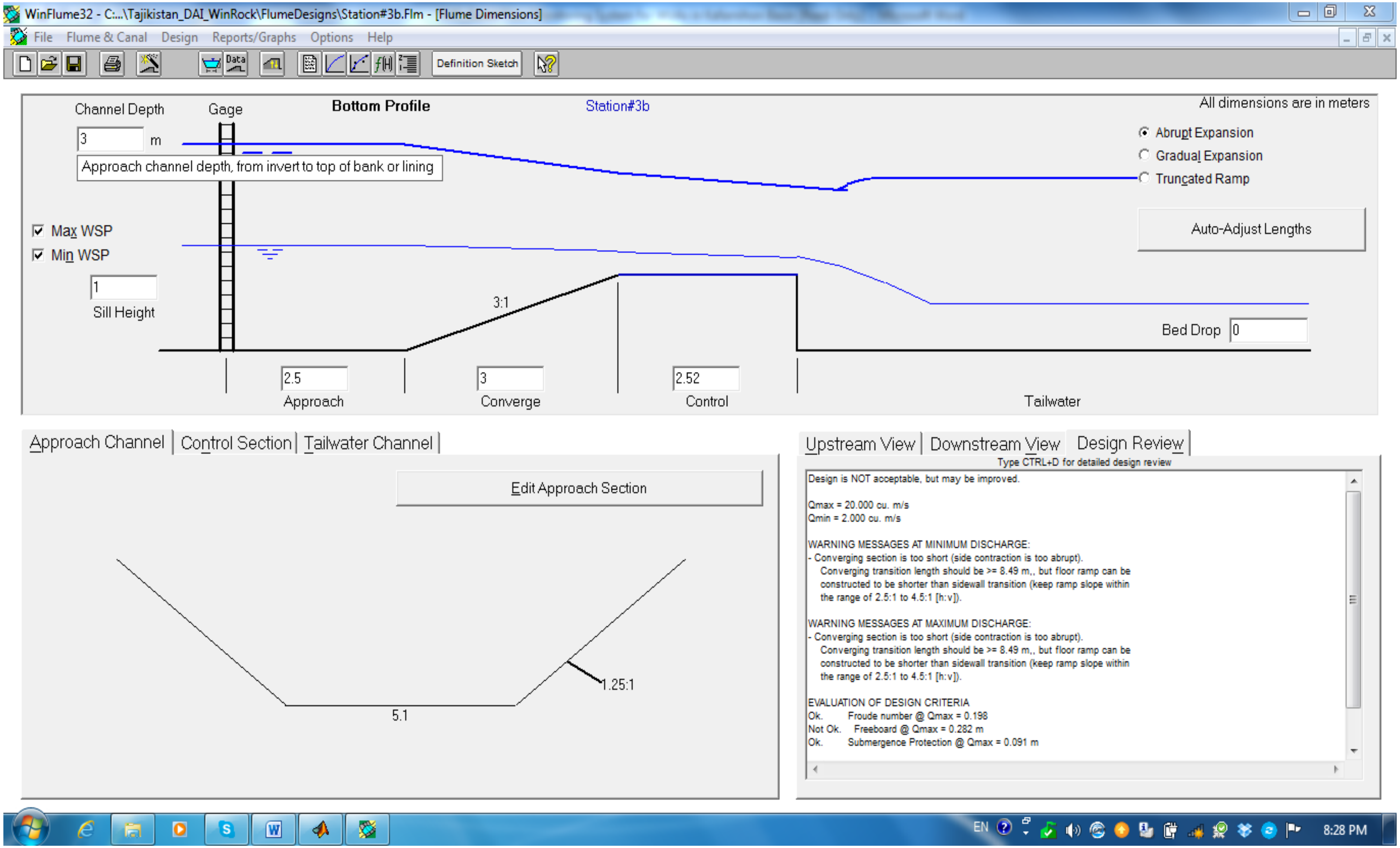
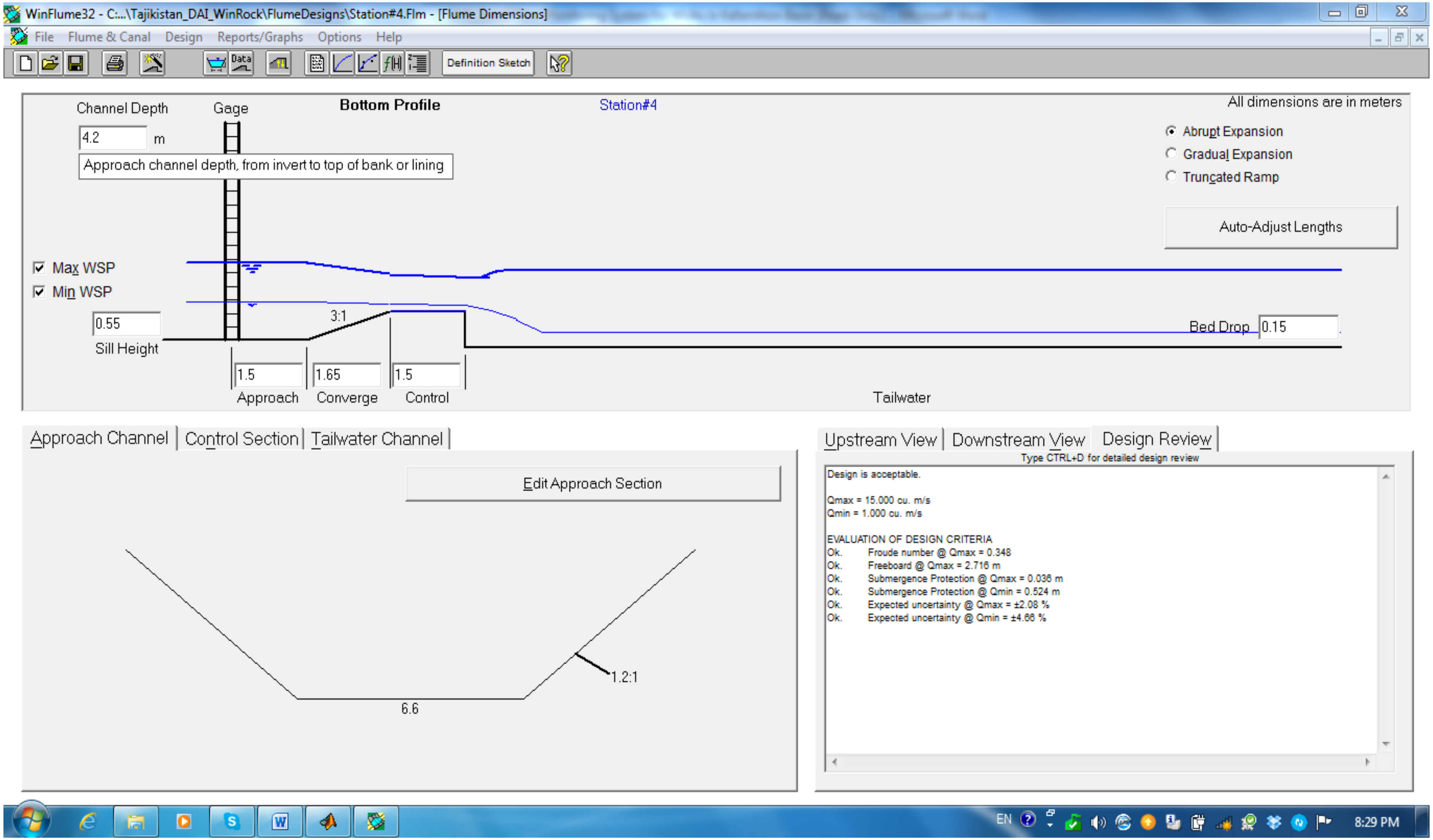
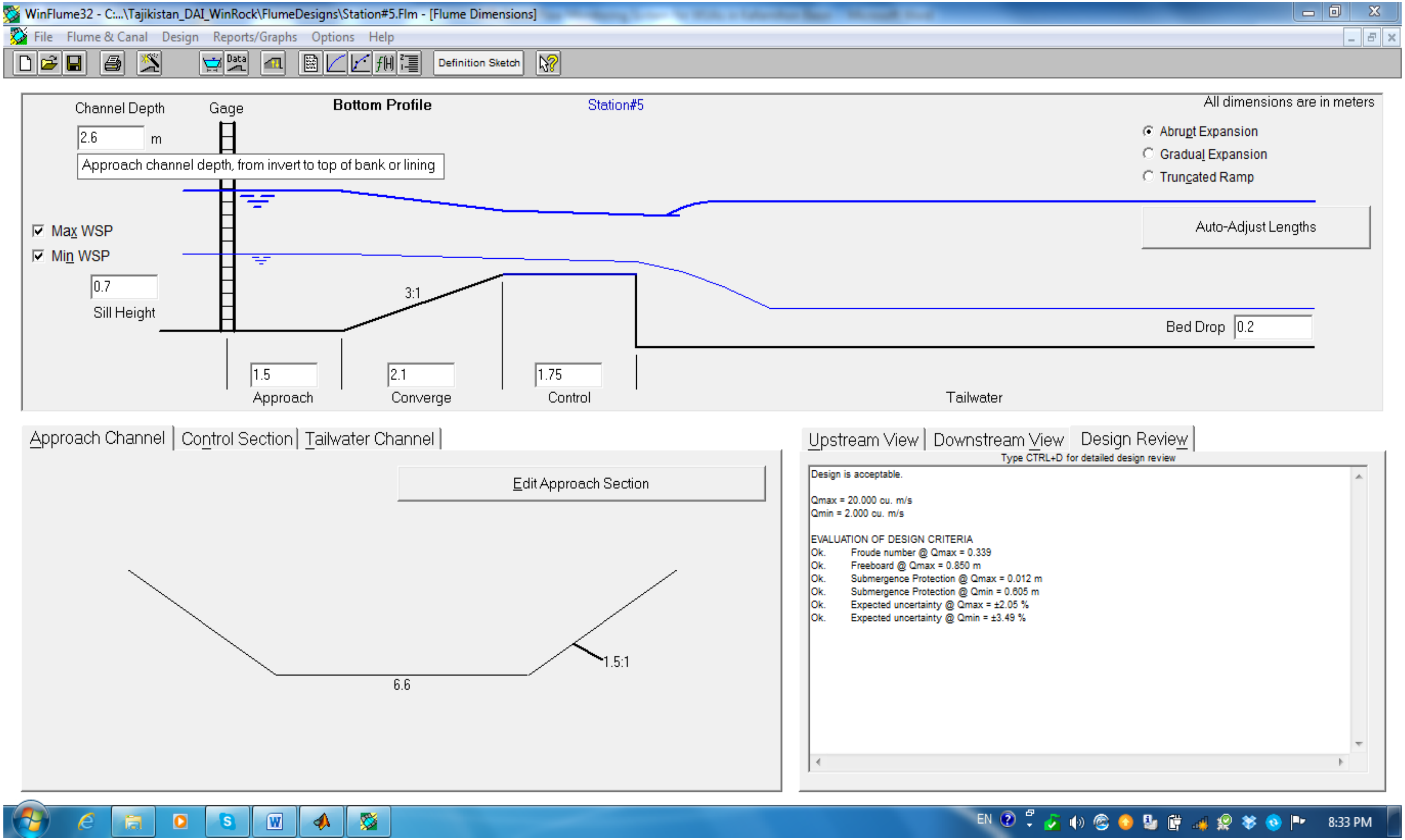
Ok. Freeboard @ Qmax = 0.617 m
Ok. Submergence Protection @ Qmax = 0.117 m
EN
8:18 PM

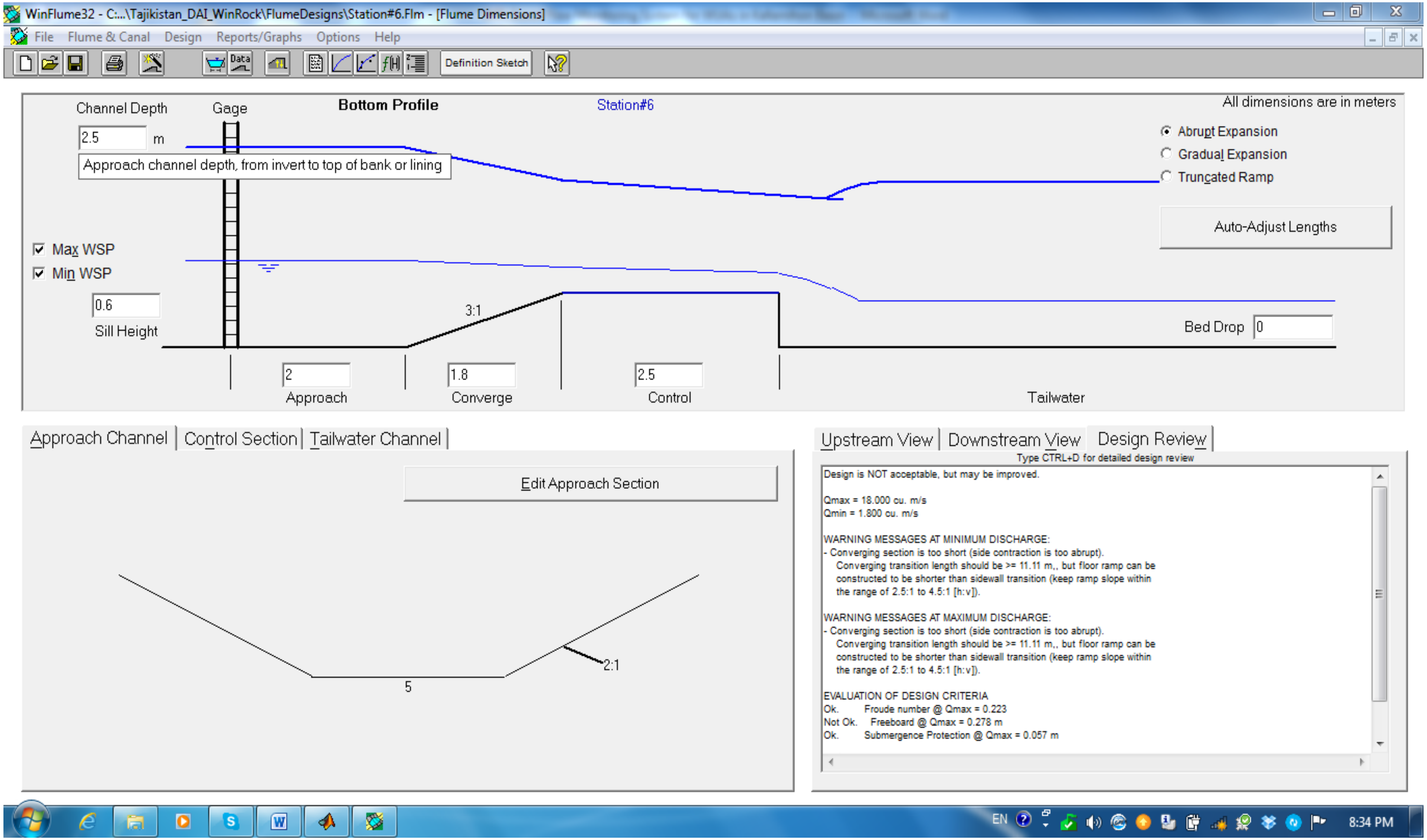


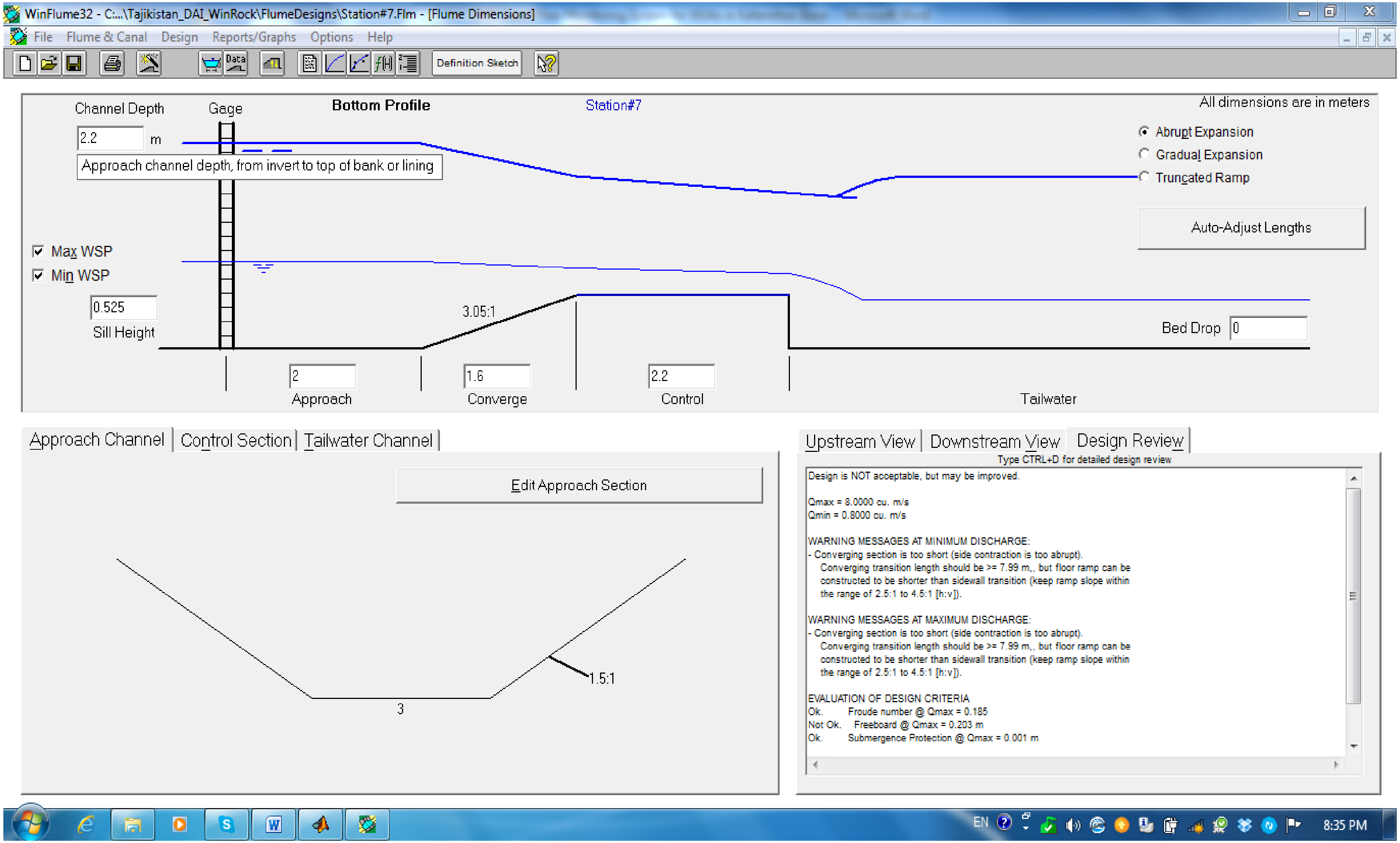
WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#3a.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
3.5
m
Gage
Bottom Profile
Station#3a
All dimensions are in meters
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.75
Sill Height
3:1
Bed Drop
0
2
Approach
2.25
Converge
3
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.9:1
4
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 20.000 cu. m/s
Qmin = 2.000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 6.20 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Gage is too close to converging section and/or throat.
Suggest approach length >= 2.07 m
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 6.20 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.254
EN
8:25 PM

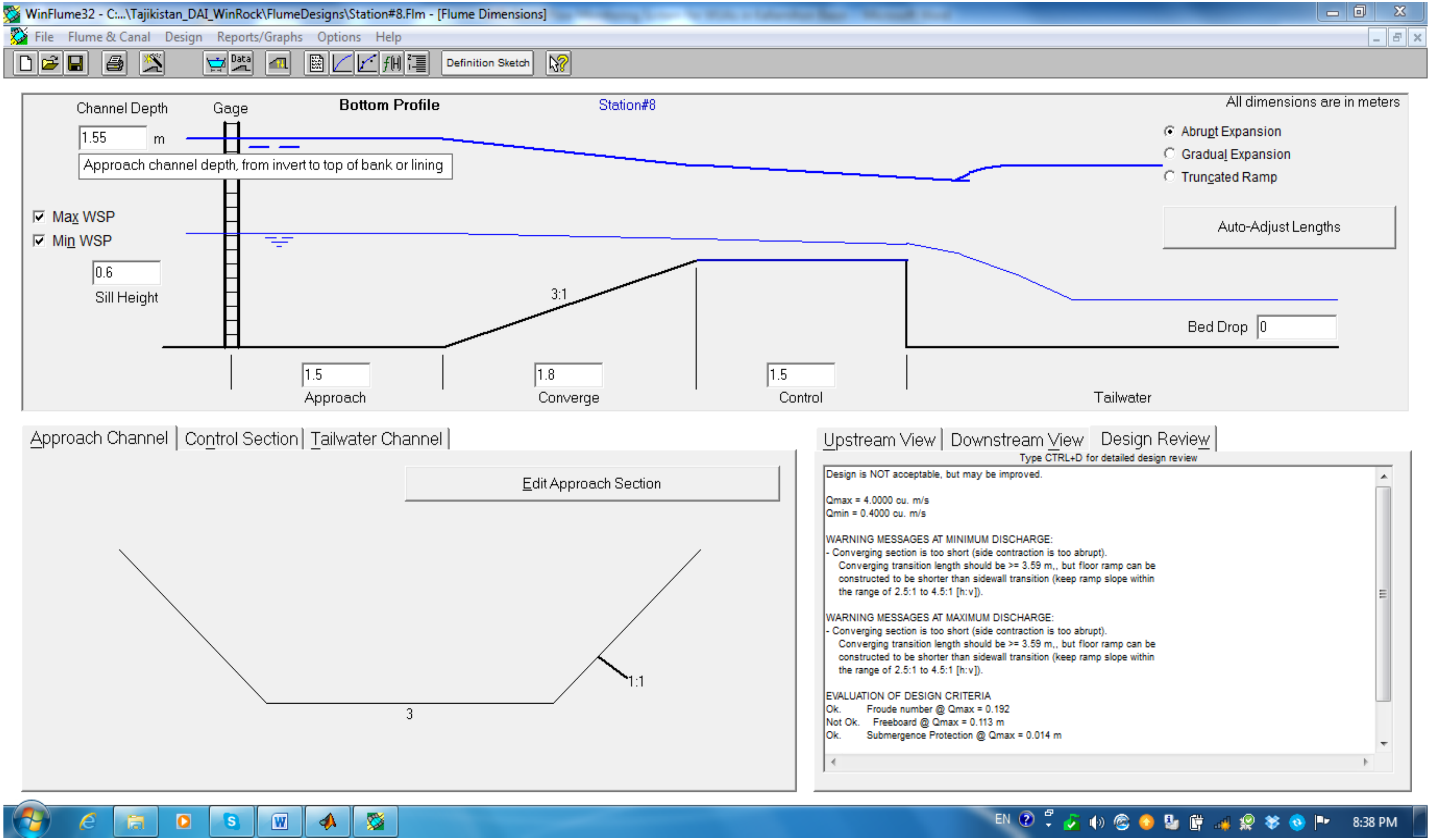

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#3b.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#3b
All dimensions are in meters
3 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
1
Sill Height
3:1
Bed Drop 0
2.5
Approach
3
Converge
2.52
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.25:1
5.1
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 20.000 cu. m/s
Qmin = 2.000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 8.49 m,, but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 8.49 m,, but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.198
Not Ok. Freeboard @ Qmax = 0.282 m
Ok. Submergence Protection @ Qmax = 0.091 m
EN
8:28 PM

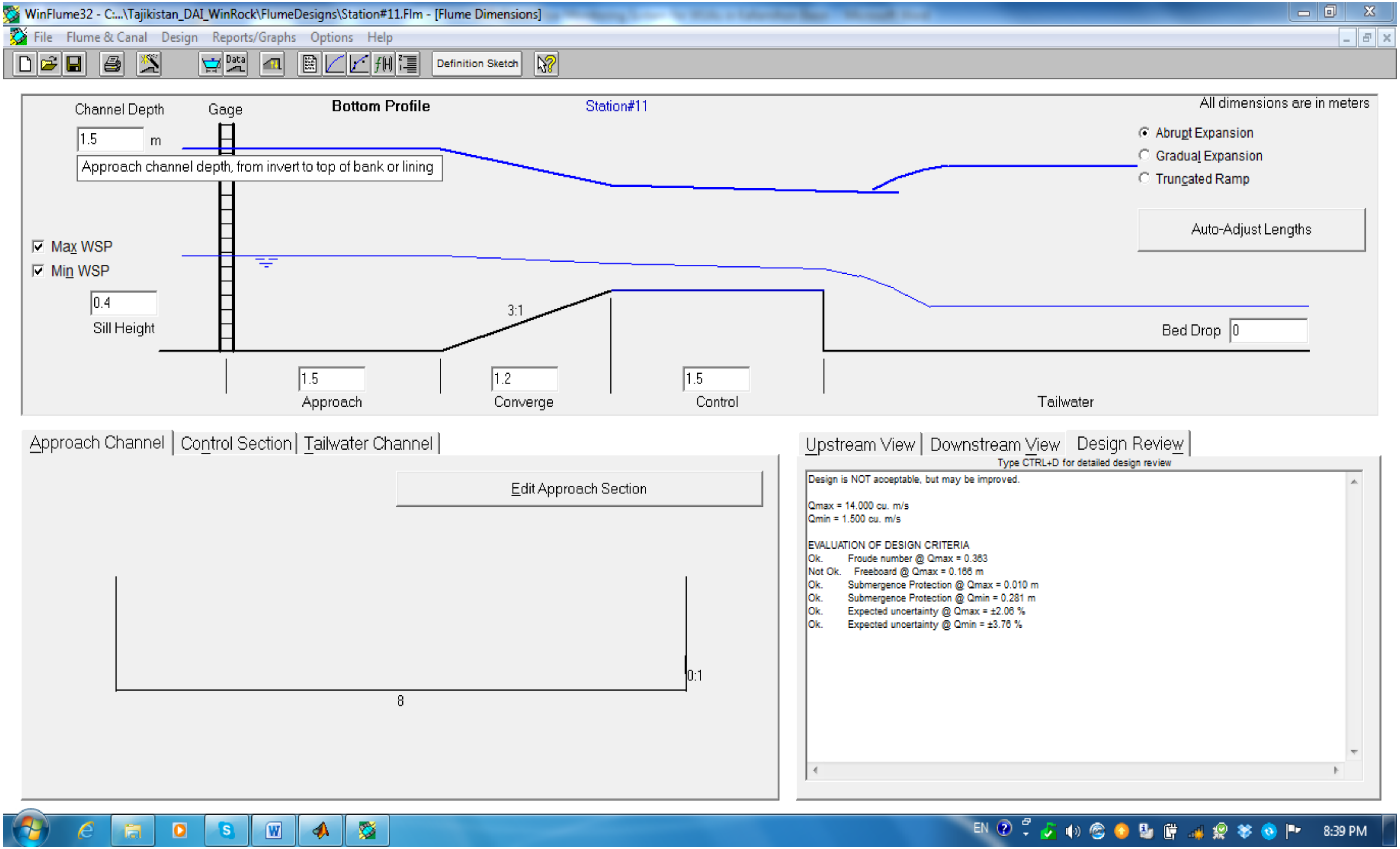

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#4.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#4
All dimensions are in meters
4.2 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.55
Sill Height
3:1
Bed Drop 0.15
1.5
1.65
1.5
Approach
Converge
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.2:1
6.6
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 15.000 cu. m/s
Qmin = 1.000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.348
Ok. Freeboard @ Qmax = 2.716 m
Ok. Submergence Protection @ Qmax = 0.036 m
Ok. Submergence Protection @ Qmin = 0.524 m
Ok. Expected uncertainty @ Qmax = ±2.08 %
Ok. Expected uncertainty @ Qmin = ±4.66 %
EN
8:29 PM

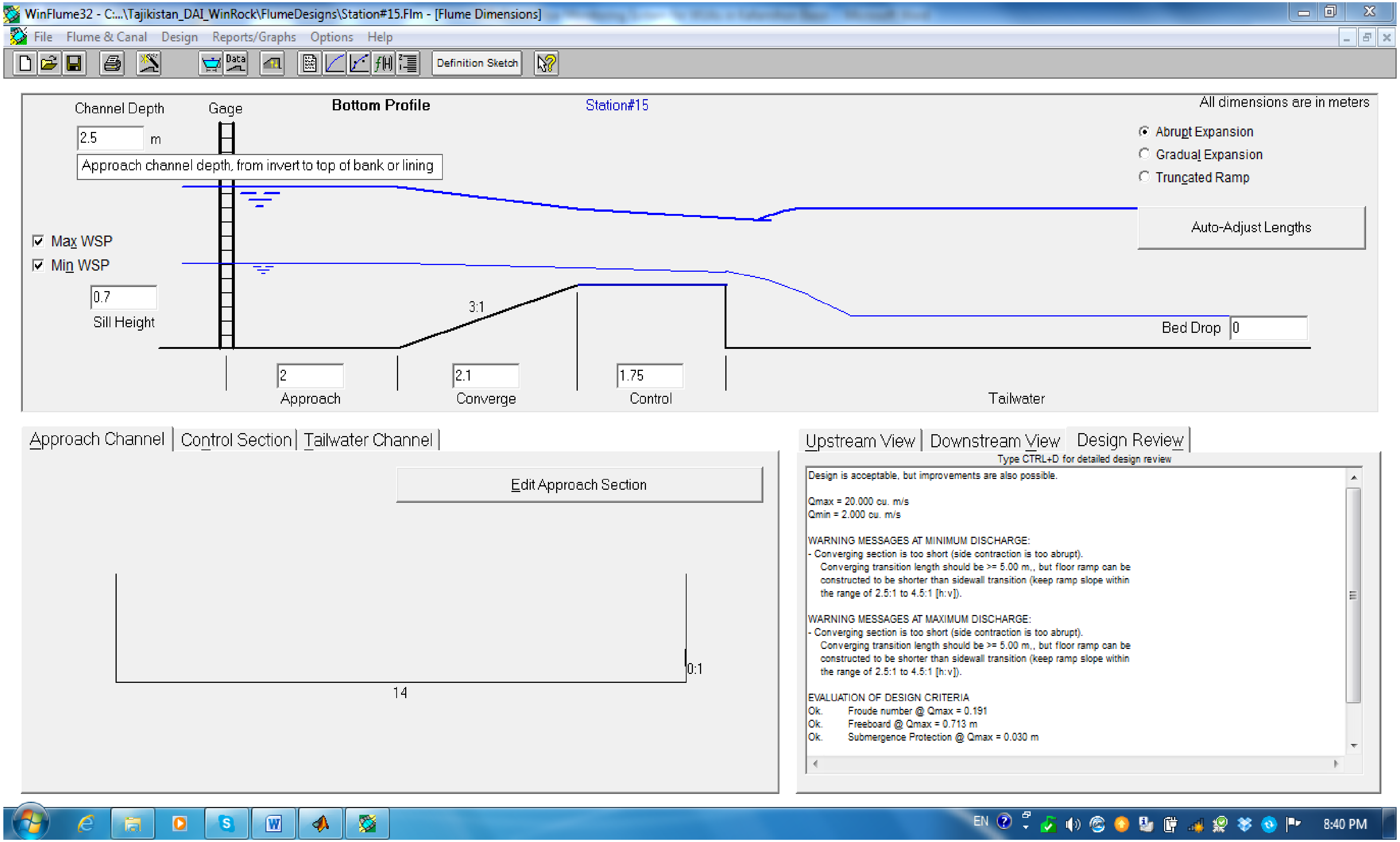

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#5.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#5
All dimensions are in meters
2.6 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.7
Sill Height
3:1
Bed Drop 0.2
1.5
Approach
2.1
Converge
1.75
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.5:1
6.6
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 20.000 cu. m/s
Qmin = 2.000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.339
Ok. Freeboard @ Qmax = 0.850 m
Ok. Submergence Protection @ Qmax = 0.012 m
Ok. Submergence Protection @ Qmin = 0.605 m
Ok. Expected uncertainty @ Qmax = ±2.05 %
Ok. Expected uncertainty @ Qmin = ±3.49 %
EN
8:33 PM

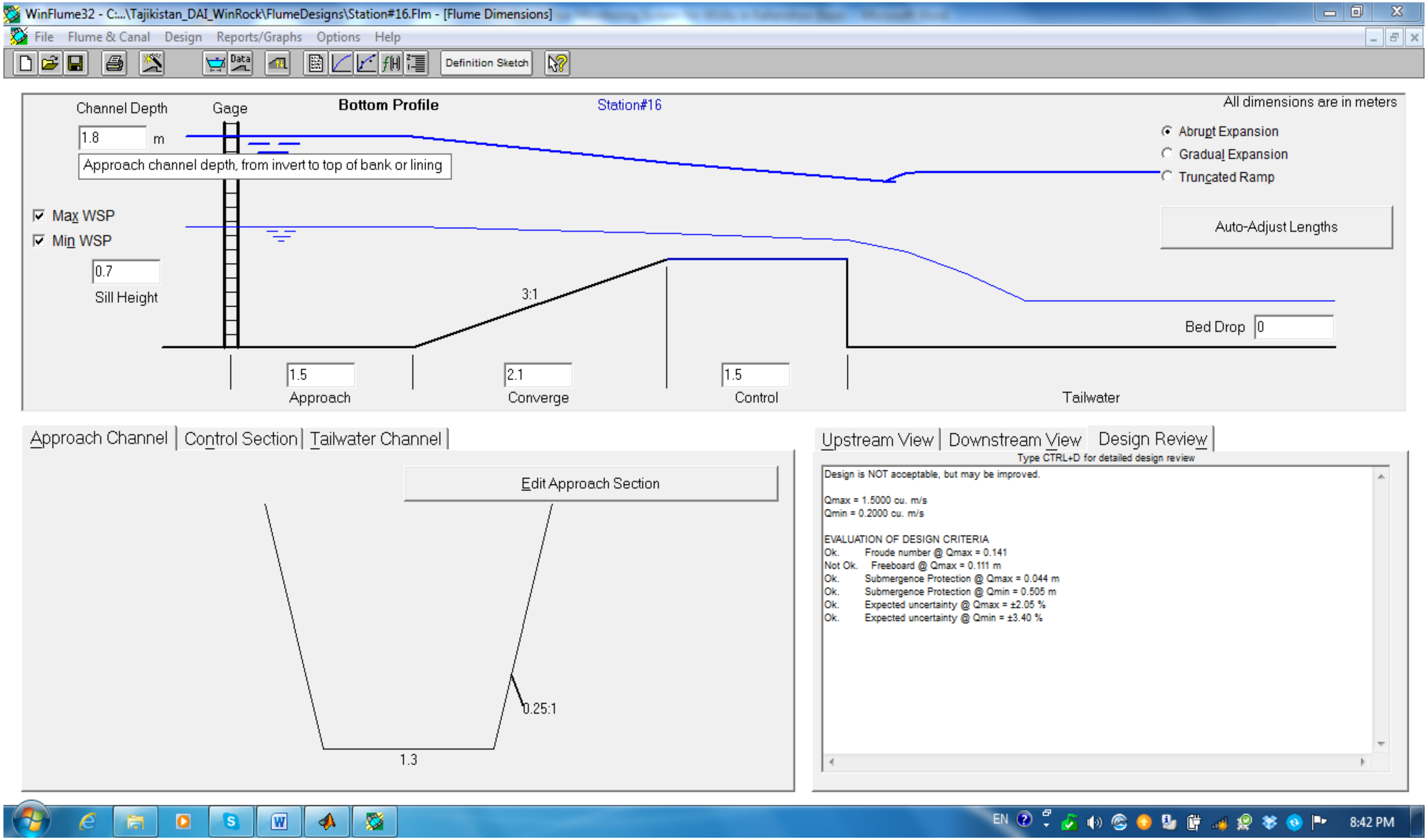

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#6.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#6
All dimensions are in meters
2.5 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.6
Sill Height
3:1
Bed Drop 0
2
Approach
1.8
Converge
2.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
5
2:1
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 18.000 cu. m/s
Qmin = 1.800 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 11.11 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 11.11 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.223
Not Ok. Freeboard @ Qmax = 0.278 m
Ok. Submergence Protection @ Qmax = 0.057 m
EN
8:34 PM

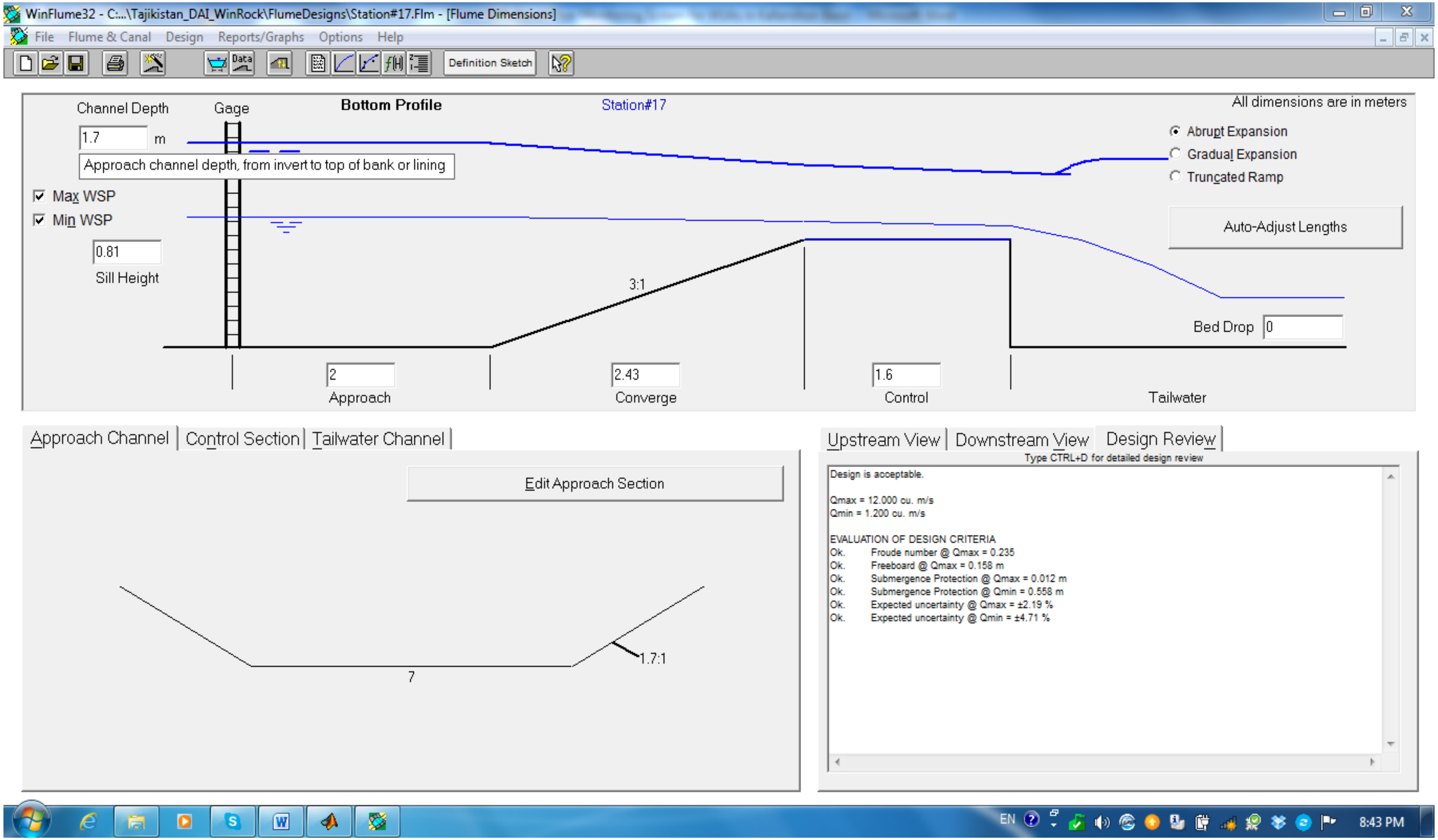

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#7.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#7
All dimensions are in meters
2.2
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.525
Sill Height
3.05:1
Bed Drop
0
2
Approach
1.6
Converge
2.2
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.5:1
3
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 8.0000 cu. m/s
Qmin = 0.8000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 7.99 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 7.99 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.185
Not Ok. Freeboard @ Qmax = 0.203 m
Ok. Submergence Protection @ Qmax = 0.001 m
EN
8:35 PM

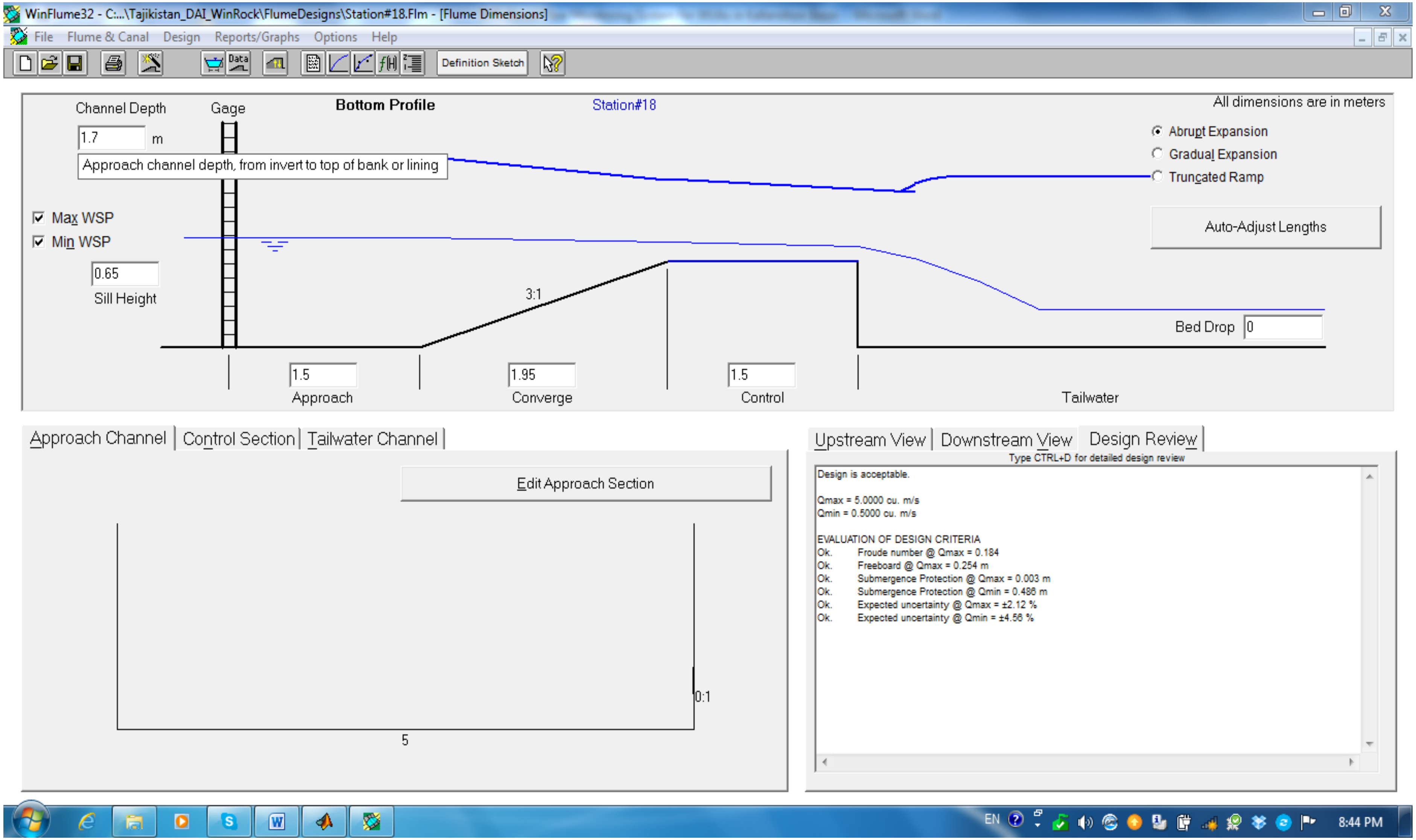

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#8.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#8
All dimensions are in meters
1.55
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.6
Sill Height
3:1
Bed Drop
0
1.5
Approach
1.8
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1:1
3
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 4.0000 cu. m/s
Qmin = 0.4000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.59 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.59 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.192
Not Ok. Freeboard @ Qmax = 0.113 m
Ok. Submergence Protection @ Qmax = 0.014 m
EN
8:38 PM

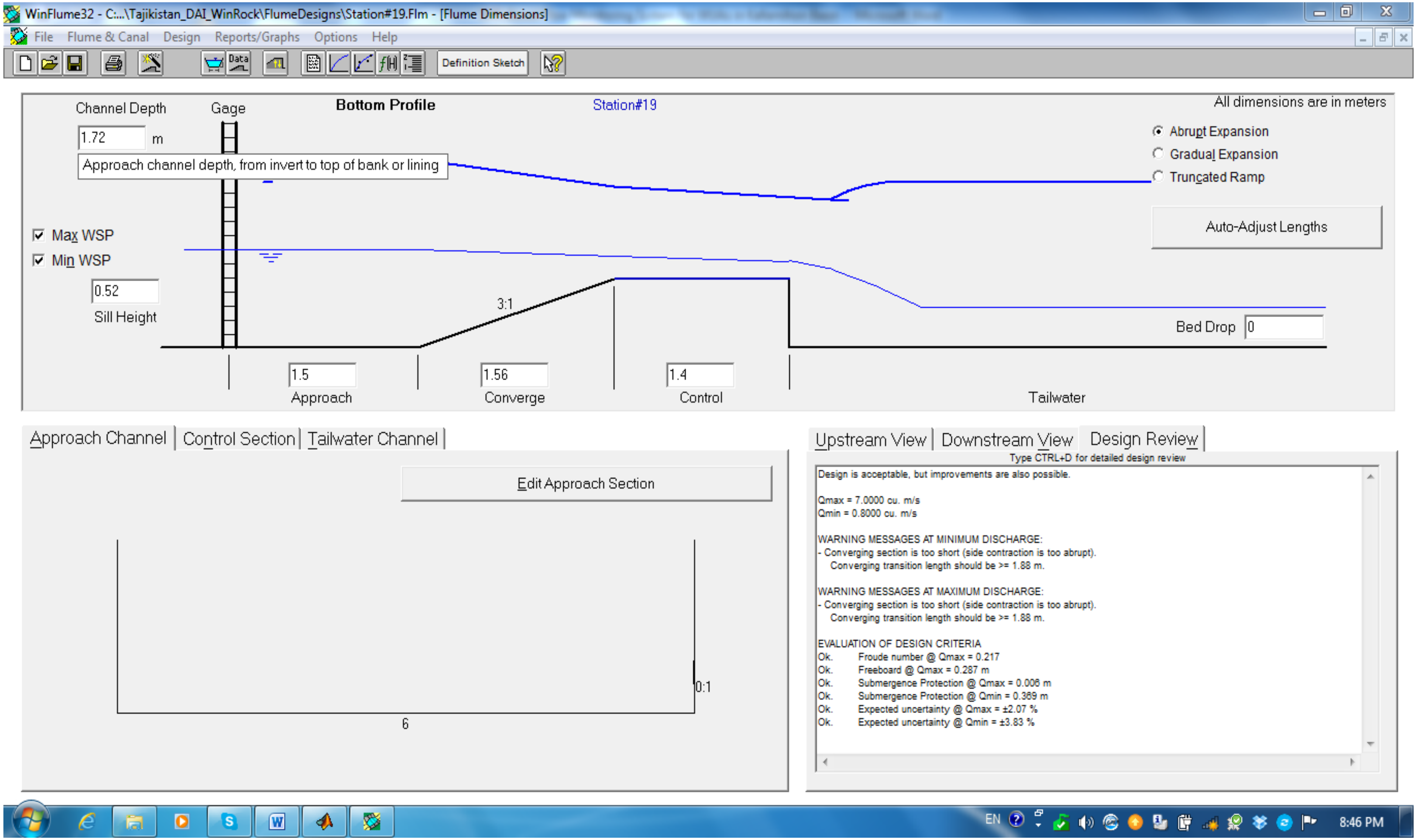

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#11.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#11
All dimensions are in meters
1.5 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.4
Sill Height
3:1
Bed Drop 0
1.5
Approach
1.2
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
8
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 14.000 cu. m/s
Qmin = 1.500 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.363
Not Ok. Freeboard @ Qmax = 0.166 m
Ok. Submergence Protection @ Qmax = 0.010 m
Ok. Submergence Protection @ Qmin = 0.281 m
Ok. Expected uncertainty @ Qmax = ±2.06 %
Ok. Expected uncertainty @ Qmin = ±3.78 %
EN
8:39 PM

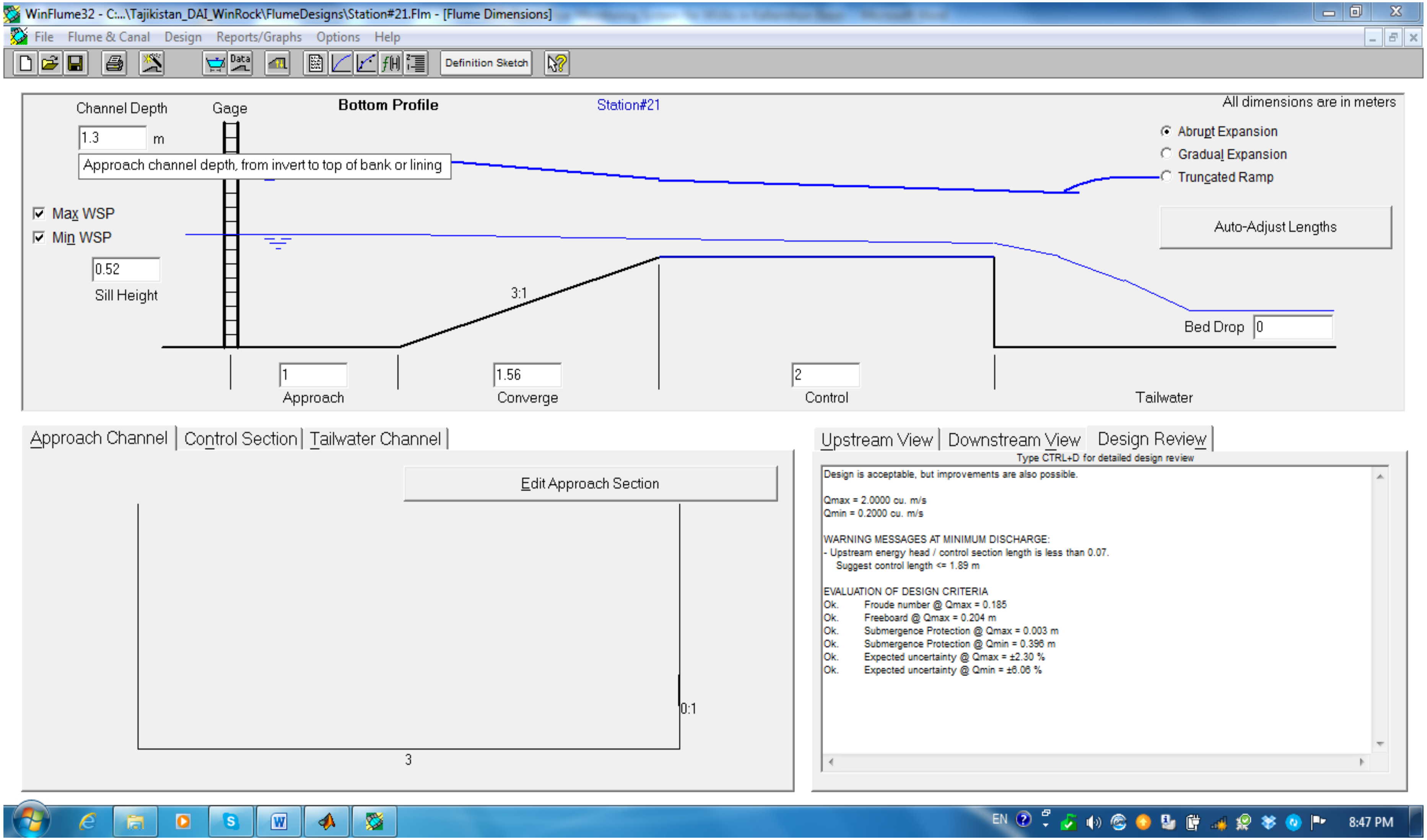

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#15.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#15
All dimensions are in meters
2.5 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.7
Sill Height
3:1
Bed Drop 0
2
Approach
2.1
Converge
1.75
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
14
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 20.000 cu. m/s
Qmin = 2.000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 5.00 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 5.00 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.191
Ok. Freeboard @ Qmax = 0.713 m
Ok. Submergence Protection @ Qmax = 0.030 m
EN
8:40 PM

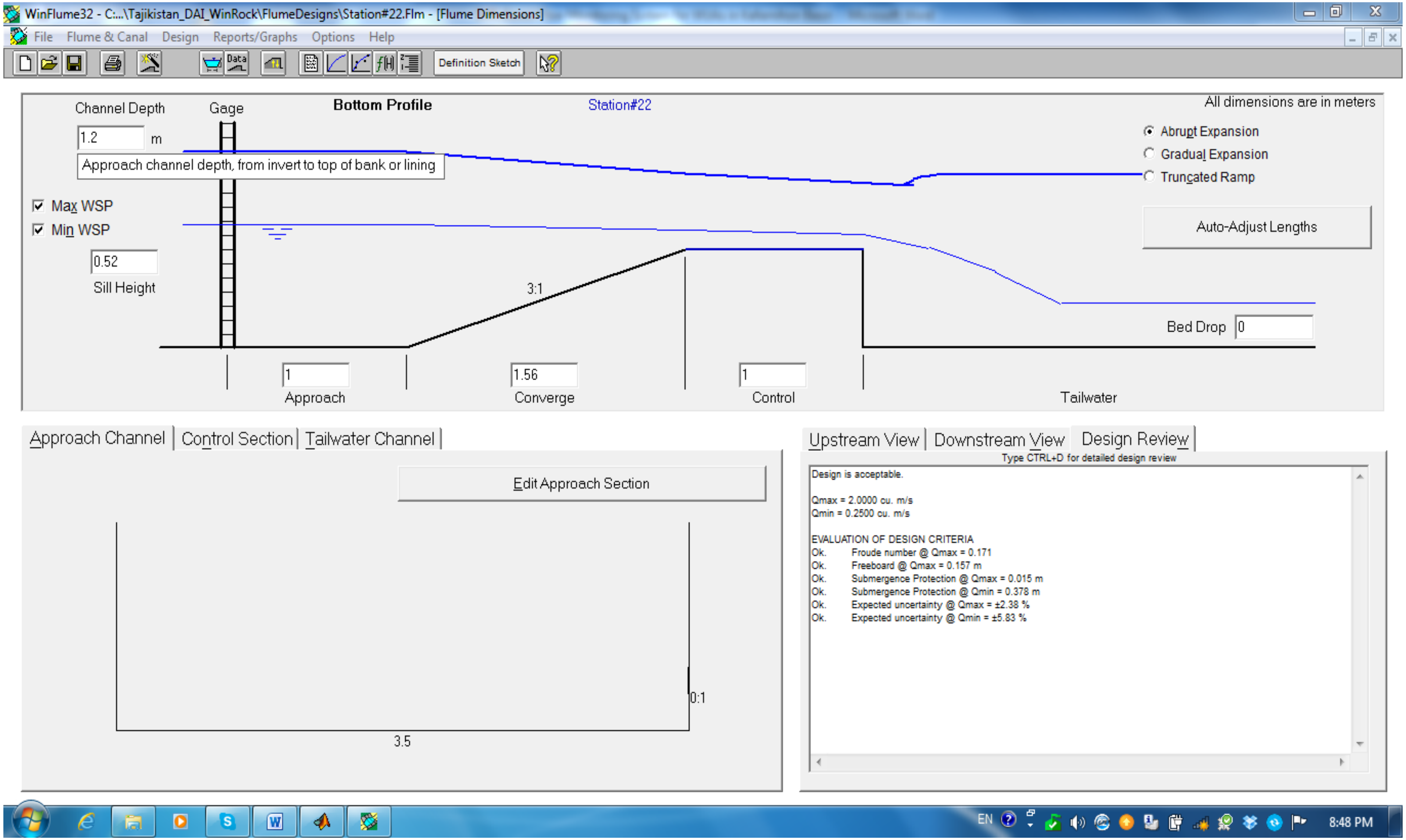

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#16.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#16
All dimensions are in meters
1.8 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.7
Sill Height
3:1
Bed Drop 0
1.5
Approach
2.1
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.25:1
1.3
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 1.5000 cu. m/s
Qmin = 0.2000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.141
Not Ok. Freeboard @ Qmax = 0.111 m
Ok. Submergence Protection @ Qmax = 0.044 m
Ok. Submergence Protection @ Qmin = 0.505 m
Ok. Expected uncertainty @ Qmax = ±2.05 %
Ok. Expected uncertainty @ Qmin = ±3.40 %
EN
8:42 PM

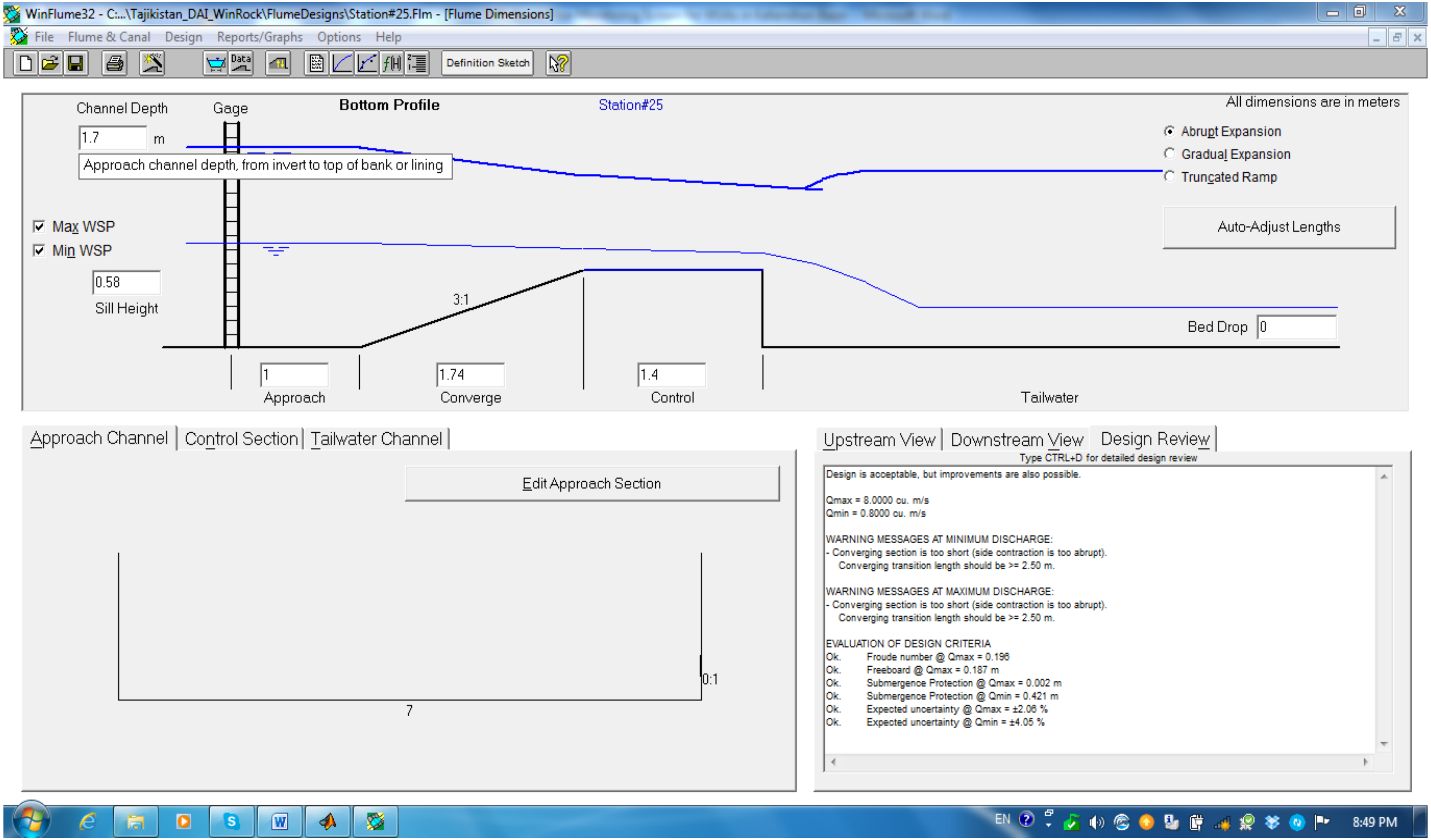

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#17.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#17
All dimensions are in meters
1.7 m
Approach channel depth, from invert to top of bank or lining
Max WSP
Min WSP
0.81
Sill Height
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
3:1
Bed Drop 0
2
Approach
2.43
Converge
1.6
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
7
1.7:1
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 12.000 cu. m/s
Qmin = 1.200 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.235
Ok. Freeboard @ Qmax = 0.158 m
Ok. Submergence Protection @ Qmax = 0.012 m
Ok. Submergence Protection @ Qmin = 0.558 m
Ok. Expected uncertainty @ Qmax = ±2.19 %
Ok. Expected uncertainty @ Qmin = ±4.71 %
EN
8:43 PM

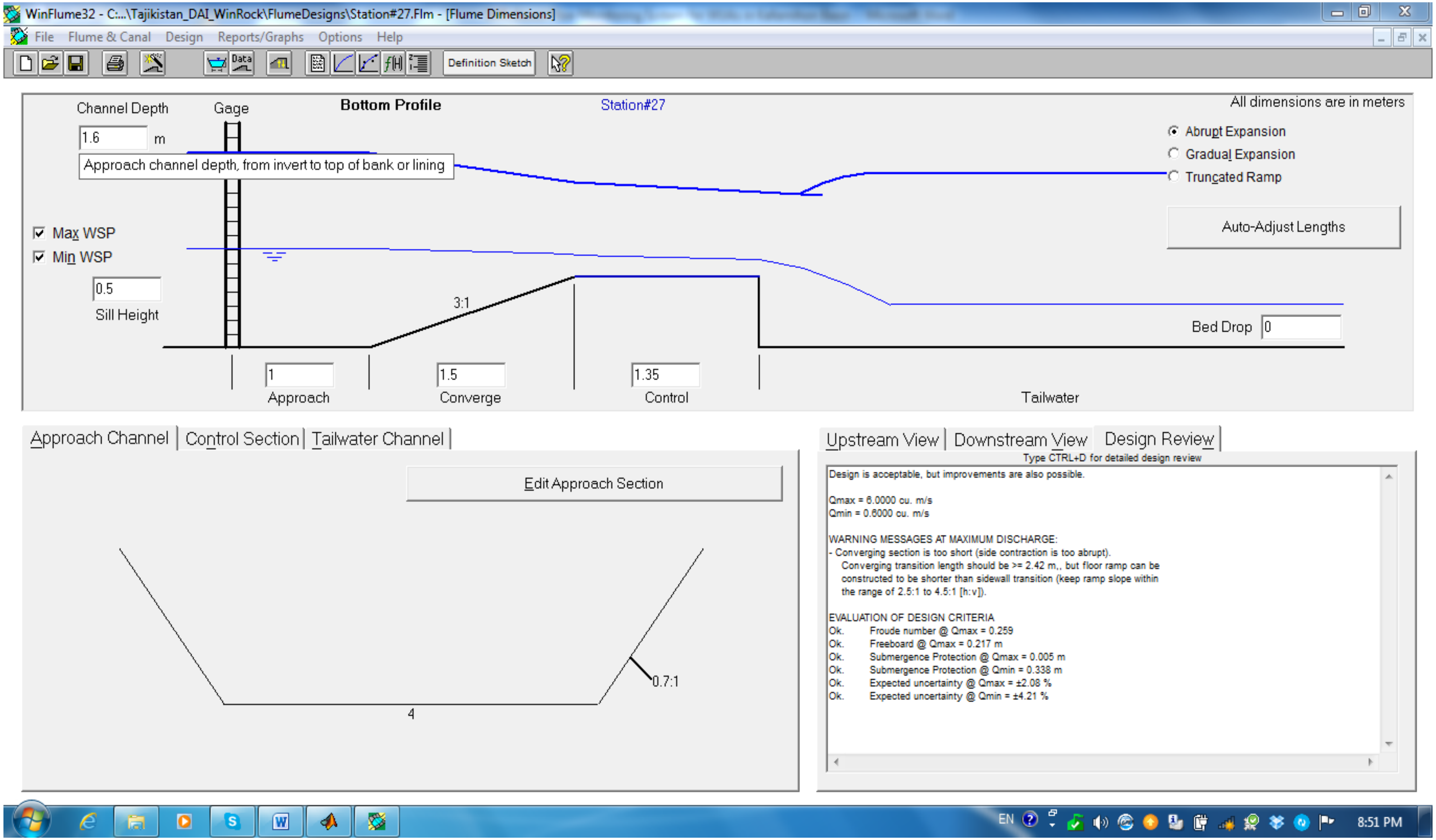

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#18.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#18
All dimensions are in meters
1.7
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.65
Sill Height
3:1
Bed Drop
0
1.5
Approach
1.95
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 5.0000 cu. m/s
Qmin = 0.5000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.184
Ok. Freeboard @ Qmax = 0.254 m
Ok. Submergence Protection @ Qmax = 0.003 m
Ok. Submergence Protection @ Qmin = 0.486 m
Ok. Expected uncertainty @ Qmax = ±2.12 %
Ok. Expected uncertainty @ Qmin = ±4.56 %
EN
8:44 PM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#19.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#19
All dimensions are in meters
1.72 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.52
Sill Height
3:1
Bed Drop 0
1.5 Approach
1.56 Converge
1.4 Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
6
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 7.0000 cu. m/s
Qmin = 0.8000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 1.88 m.
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 1.88 m.
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.217
Ok. Freeboard @ Qmax = 0.287 m
Ok. Submergence Protection @ Qmax = 0.006 m
Ok. Submergence Protection @ Qmin = 0.369 m
Ok. Expected uncertainty @ Qmax = ±2.07 %
Ok. Expected uncertainty @ Qmin = ±3.83 %
EN
8:46 PM

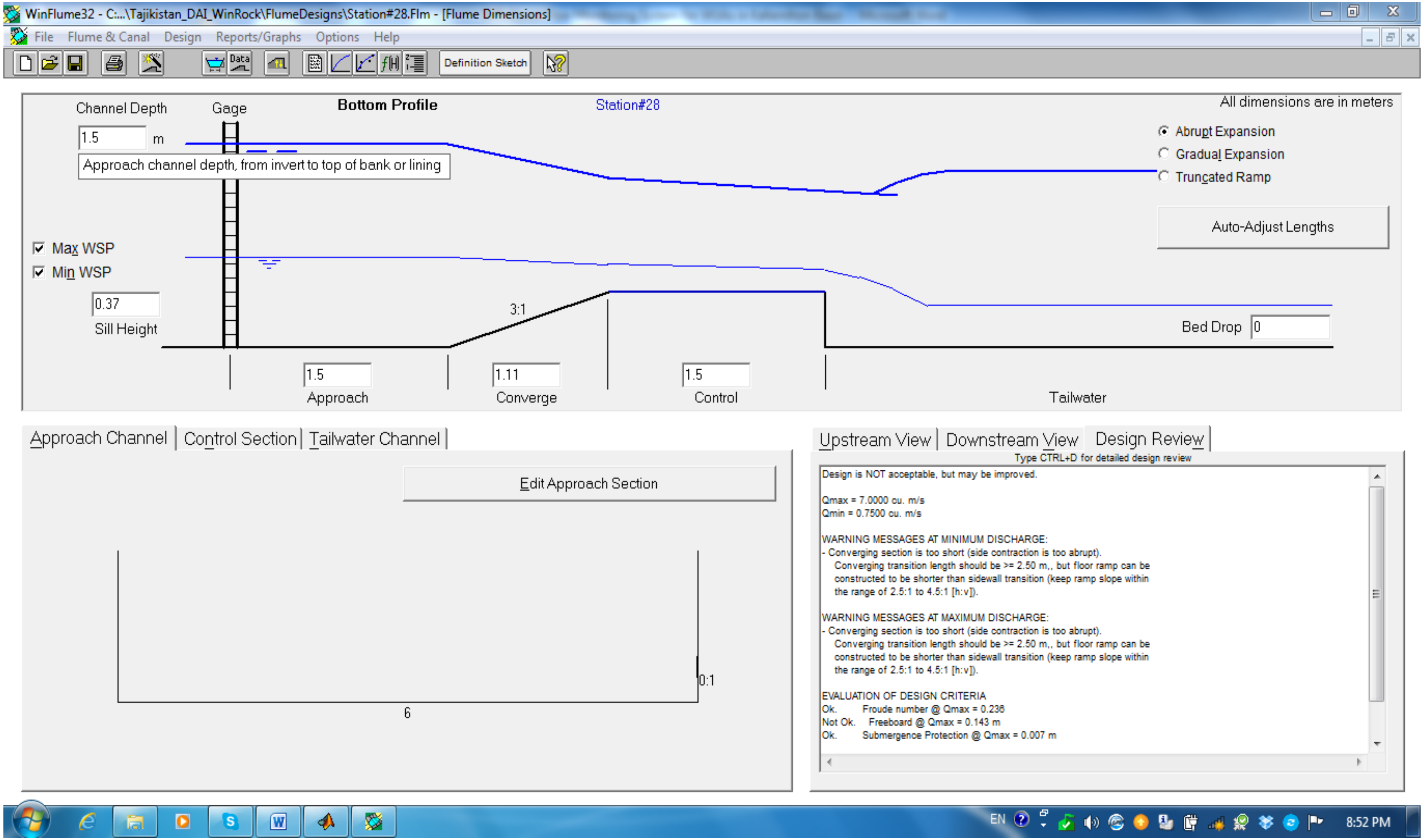

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#21.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#21
All dimensions are in meters
1.3
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.52
Sill Height
3:1
Bed Drop
0
1
Approach
1.56
Converge
2
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Edit Approach Section
0:1
3
Design is acceptable, but improvements are also possible.
Qmax = 2.0000 cu. m/s
Qmin = 0.2000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Upstream energy head / control section length is less than 0.07.
Suggest control length <= 1.89 m
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.185
Ok. Freeboard @ Qmax = 0.204 m
Ok. Submergence Protection @ Qmax = 0.003 m
Ok. Submergence Protection @ Qmin = 0.396 m
Ok. Expected uncertainty @ Qmax = ±2.30 %
Ok. Expected uncertainty @ Qmin = ±6.06 %
EN
8:47 PM

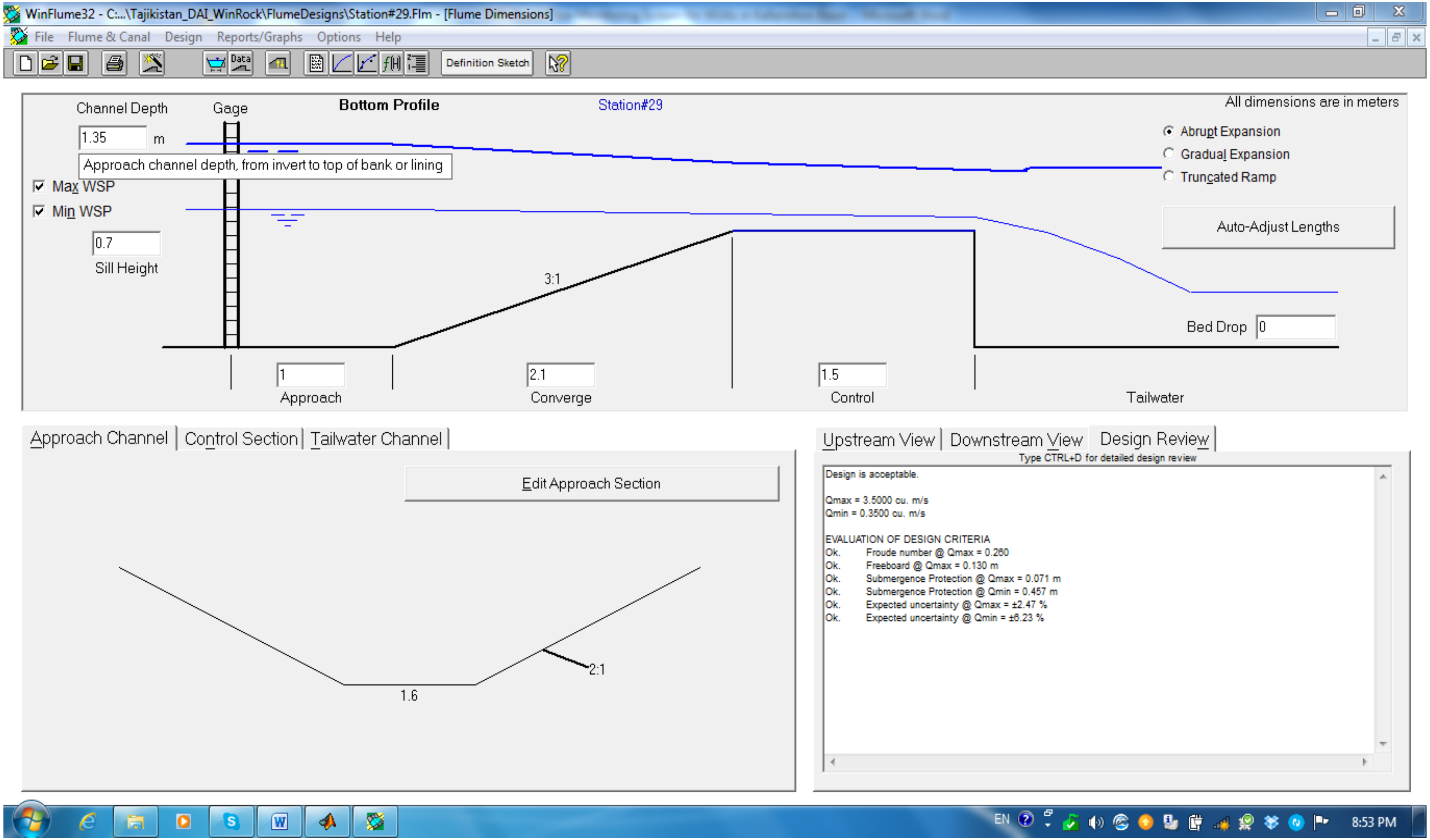

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#22.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#22
All dimensions are in meters
1.2
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.52
Sill Height
3:1
Bed Drop
0
1
1.56
1
Approach
Converge
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
3.5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 2.0000 cu. m/s
Qmin = 0.2500 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.171
Ok. Freeboard @ Qmax = 0.157 m
Ok. Submergence Protection @ Qmax = 0.015 m
Ok. Submergence Protection @ Qmin = 0.378 m
Ok. Expected uncertainty @ Qmax = ±2.38 %
Ok. Expected uncertainty @ Qmin = ±5.83 %
EN
8:48 PM

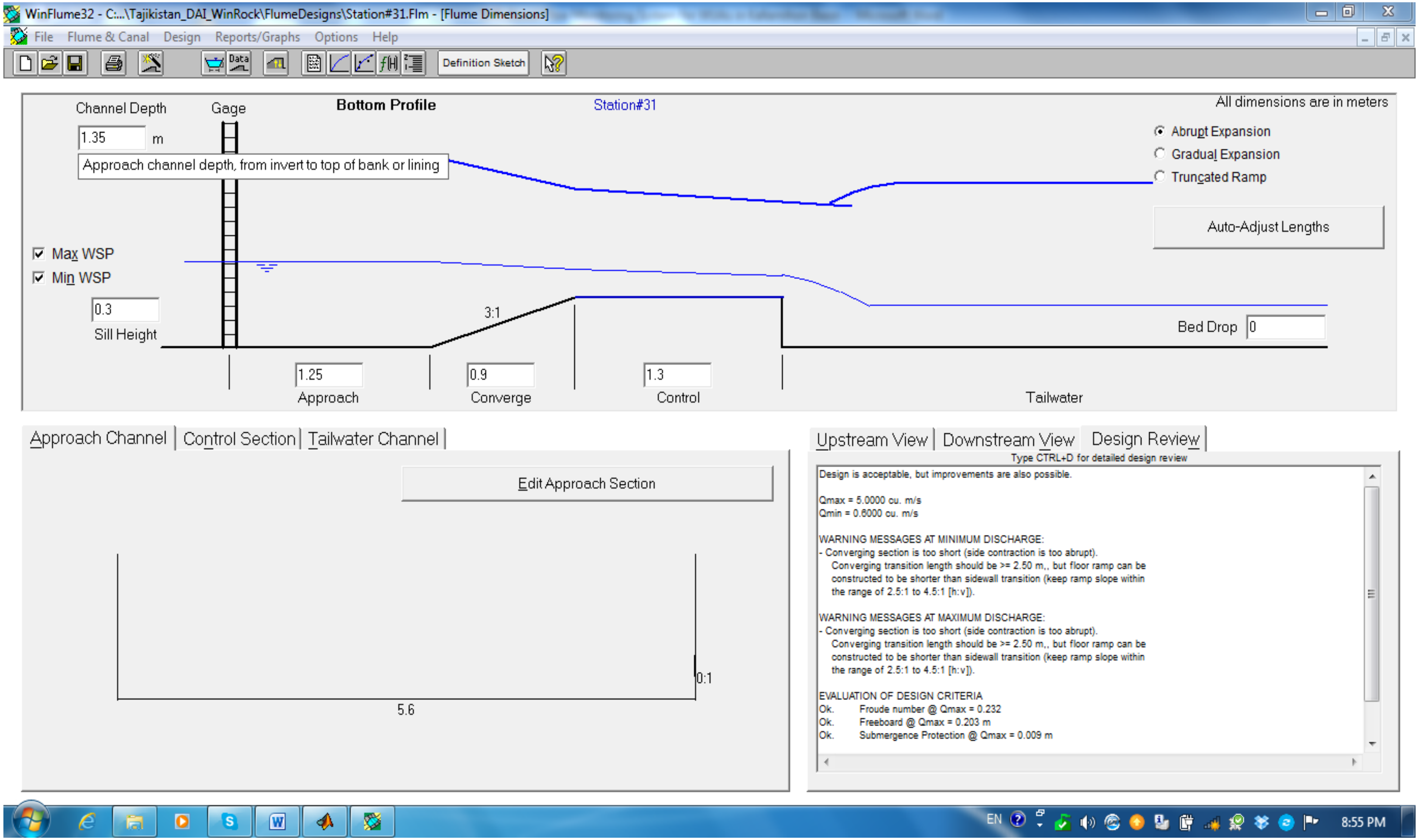

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#25.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
1.7 m
Approach channel depth, from invert to top of bank or lining
Gage
Bottom Profile
Station#25
All dimensions are in meters
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.58
Sill Height
3:1
Bed Drop 0
1
Approach
1.74
Converge
1.4
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
7
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 8.0000 cu. m/s
Qmin = 0.8000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m.
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m.
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.196
Ok. Freeboard @ Qmax = 0.187 m
Ok. Submergence Protection @ Qmax = 0.002 m
Ok. Submergence Protection @ Qmin = 0.421 m
Ok. Expected uncertainty @ Qmax = ±2.06 %
Ok. Expected uncertainty @ Qmin = ±4.05 %
EN
8:49 PM

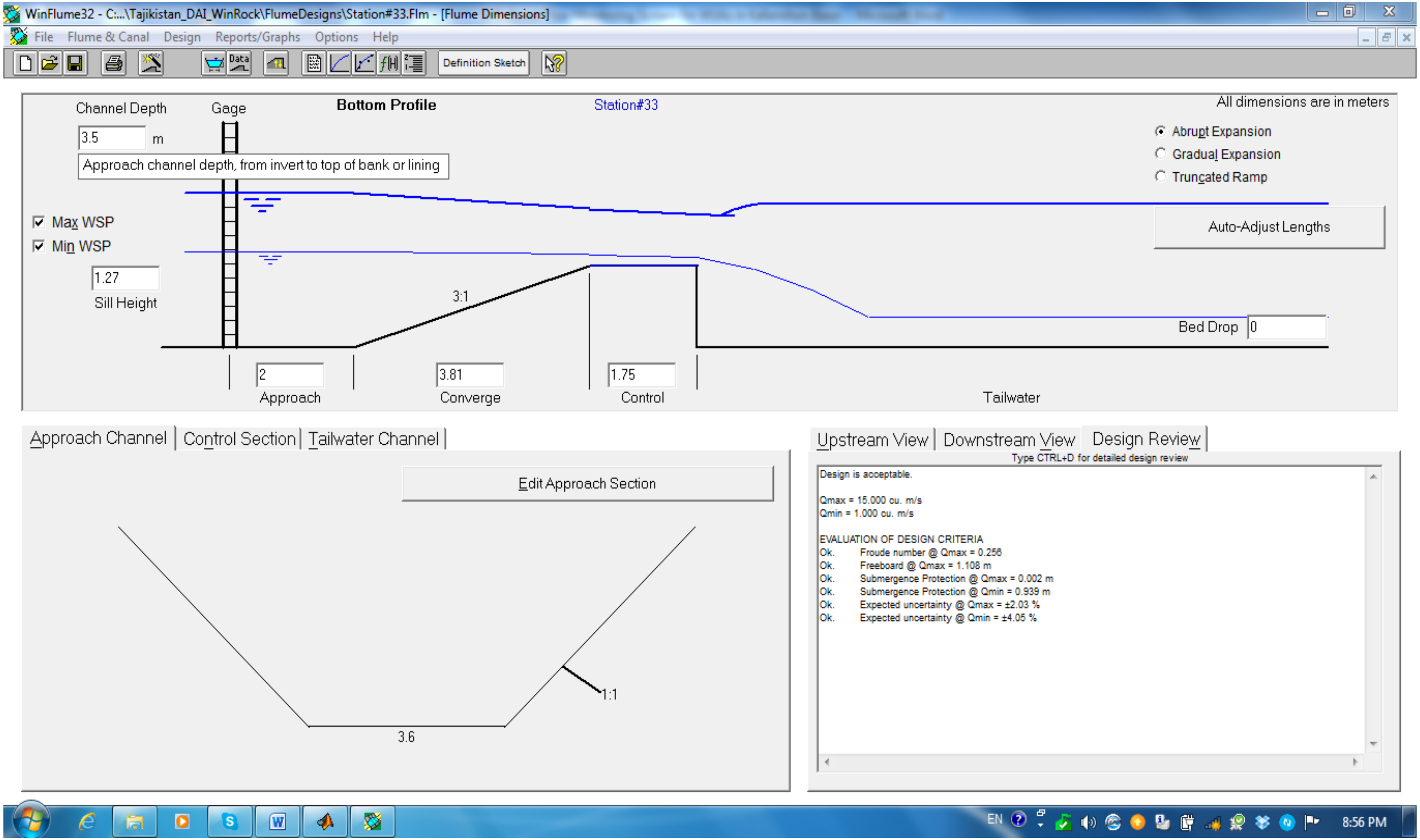


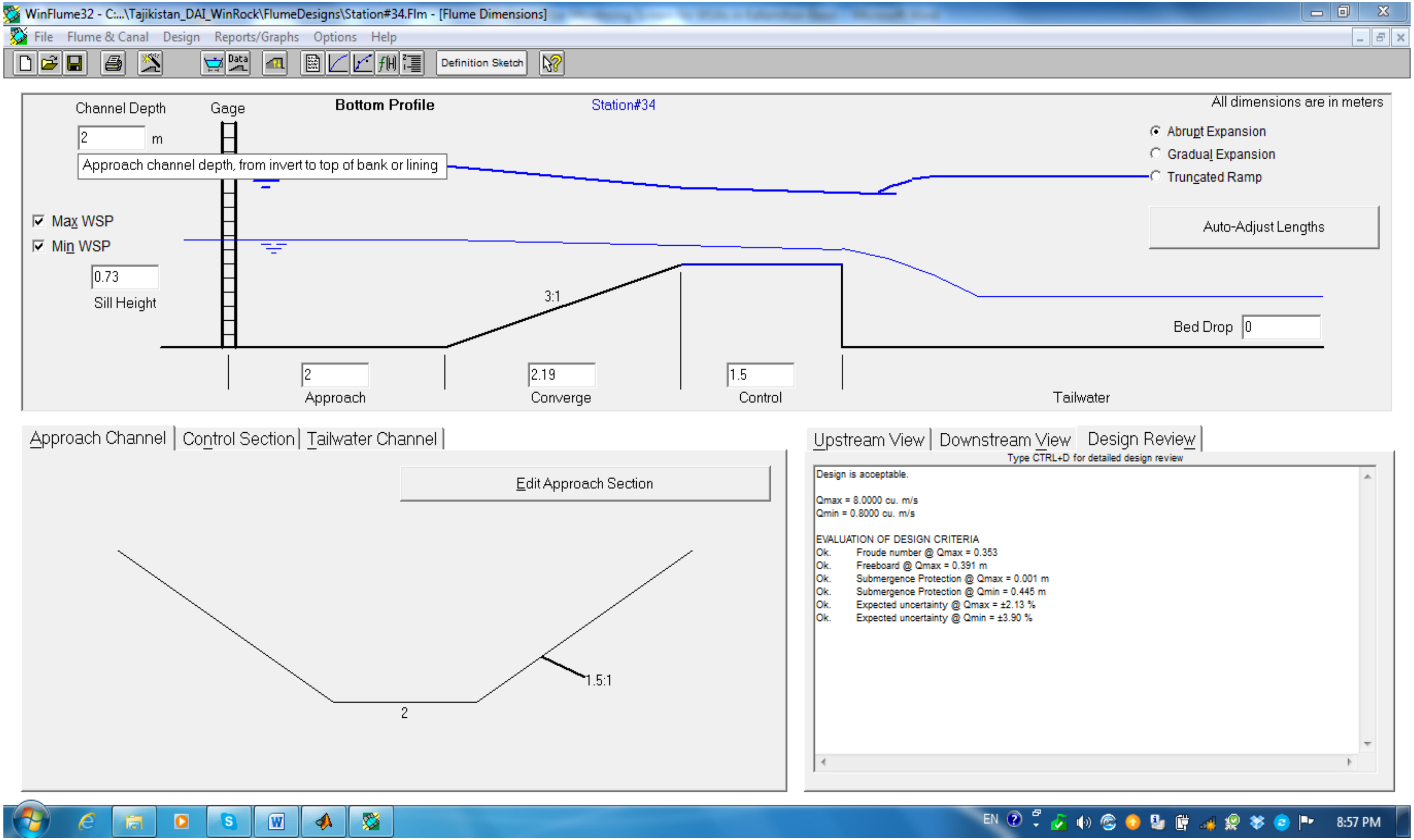
WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#27.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
1.6
m
Gage
Bottom Profile
Station#27
All dimensions are in meters
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.5
Sill Height
3:1
Bed Drop
0
1
Approach
1.5
Converge
1.35
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.7:1
4
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 6.0000 cu. m/s
Qmin = 0.6000 cu. m/s
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.42 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.259
Ok. Freeboard @ Qmax = 0.217 m
Ok. Submergence Protection @ Qmax = 0.005 m
Ok. Submergence Protection @ Qmin = 0.338 m
Ok. Expected uncertainty @ Qmax = ±2.08 %
Ok. Expected uncertainty @ Qmin = ±4.21 %
EN
8:51 PM

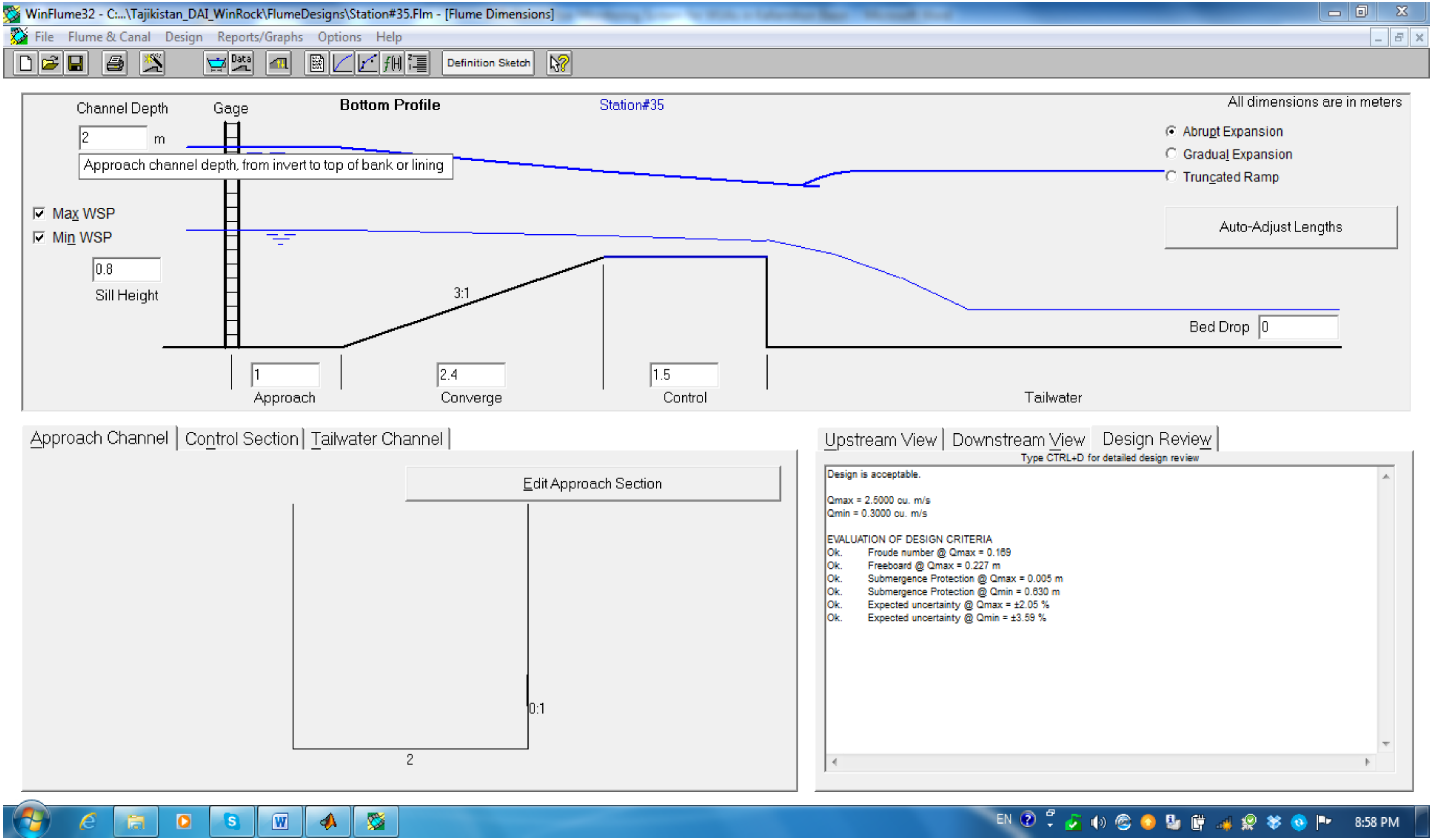

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#28.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#28
All dimensions are in meters
1.5 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.37
Sill Height
3:1
Bed Drop 0
1.5 Approach
1.11 Converge
1.5 Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
6
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is NOT acceptable, but may be improved.
Qmax = 7.0000 cu. m/s
Qmin = 0.7500 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.236
Not Ok. Freeboard @ Qmax = 0.143 m
Ok. Submergence Protection @ Qmax = 0.007 m
EN
8:52 PM

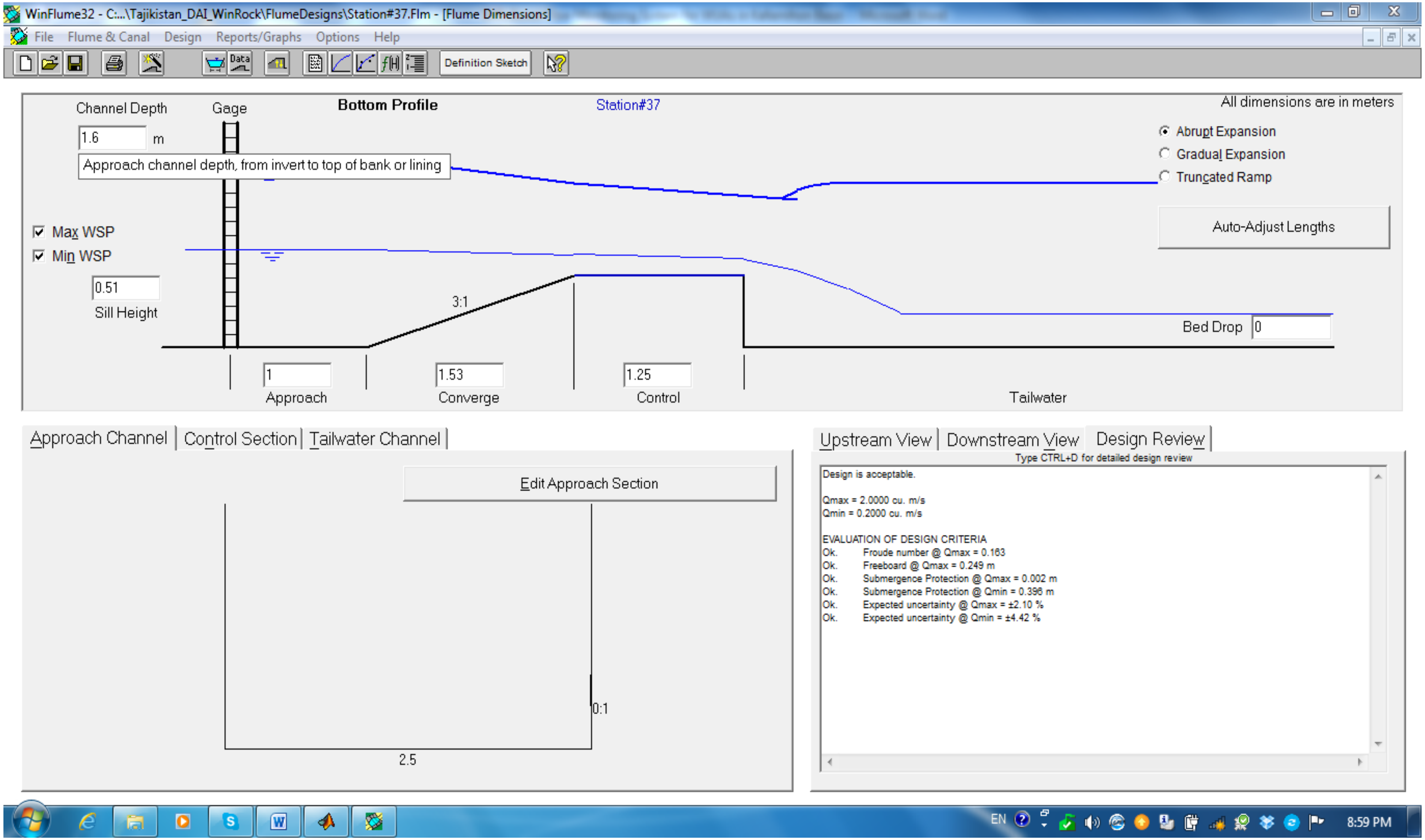

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#29.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#29
All dimensions are in meters
1.35 m
Approach channel depth, from invert to top of bank or lining
Max WSP
Min WSP
0.7
Sill Height
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
3:1
Bed Drop 0
1 Approach
2.1 Converge
1.5 Control
Tailwater
Approach Channel | Control Section | Tailwater Channel
Edit Approach Section
2:1
1.6
Upstream View | Downstream View | Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 3.5000 cu. m/s
Qmin = 0.3500 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.260
Ok. Freeboard @ Qmax = 0.130 m
Ok. Submergence Protection @ Qmax = 0.071 m
Ok. Submergence Protection @ Qmin = 0.457 m
Ok. Expected uncertainty @ Qmax = ±2.47 %
Ok. Expected uncertainty @ Qmin = ±6.23 %
EN
8:53 PM

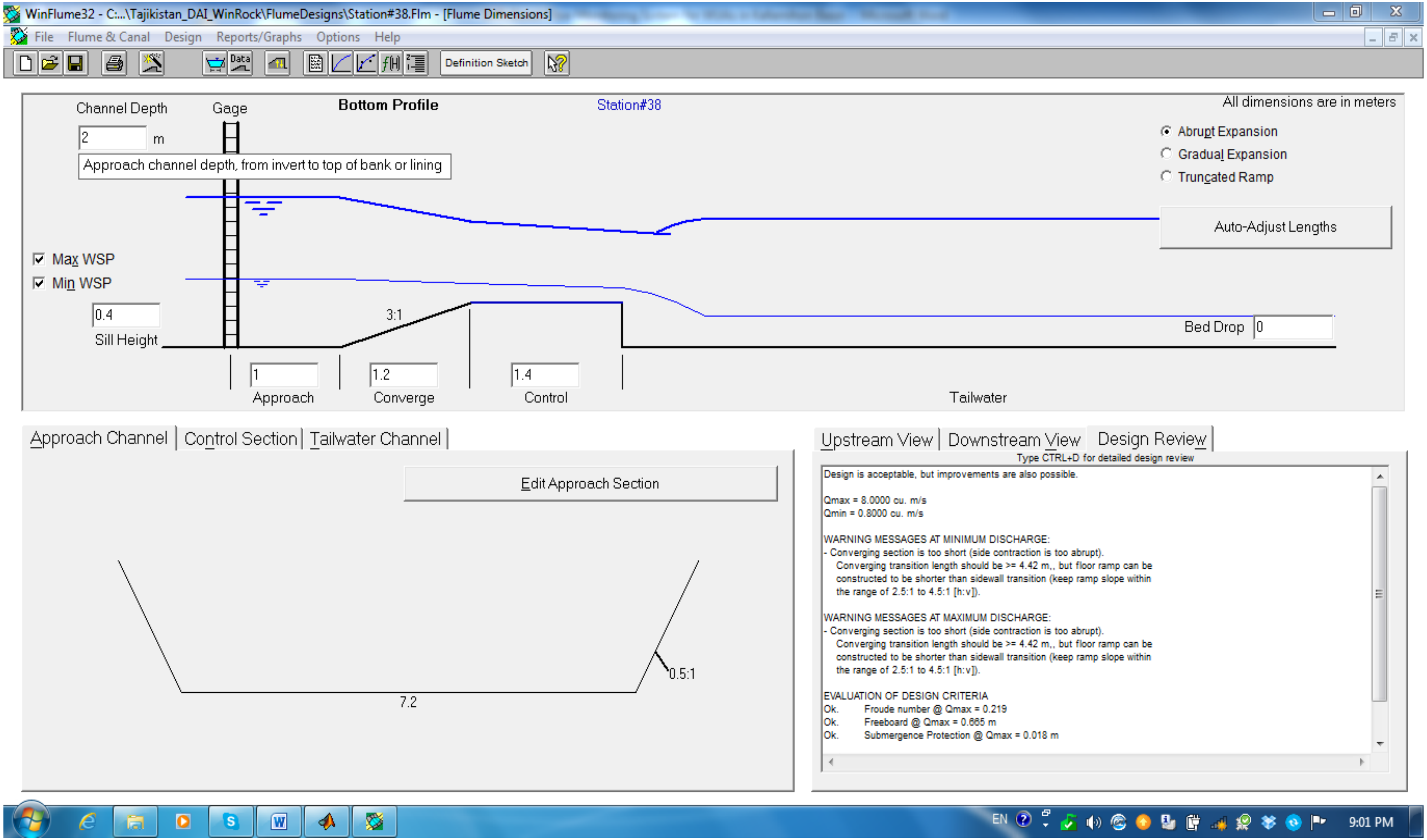

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#31.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#31
All dimensions are in meters
1.35 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.3
Sill Height
3:1
Bed Drop 0
1.25
Approach
0.9
Converge
1.3
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
5.6
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 5.0000 cu. m/s
Qmin = 0.6000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m,, but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m,, but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.232
Ok. Freeboard @ Qmax = 0.203 m
Ok. Submergence Protection @ Qmax = 0.009 m
EN
8:55 PM

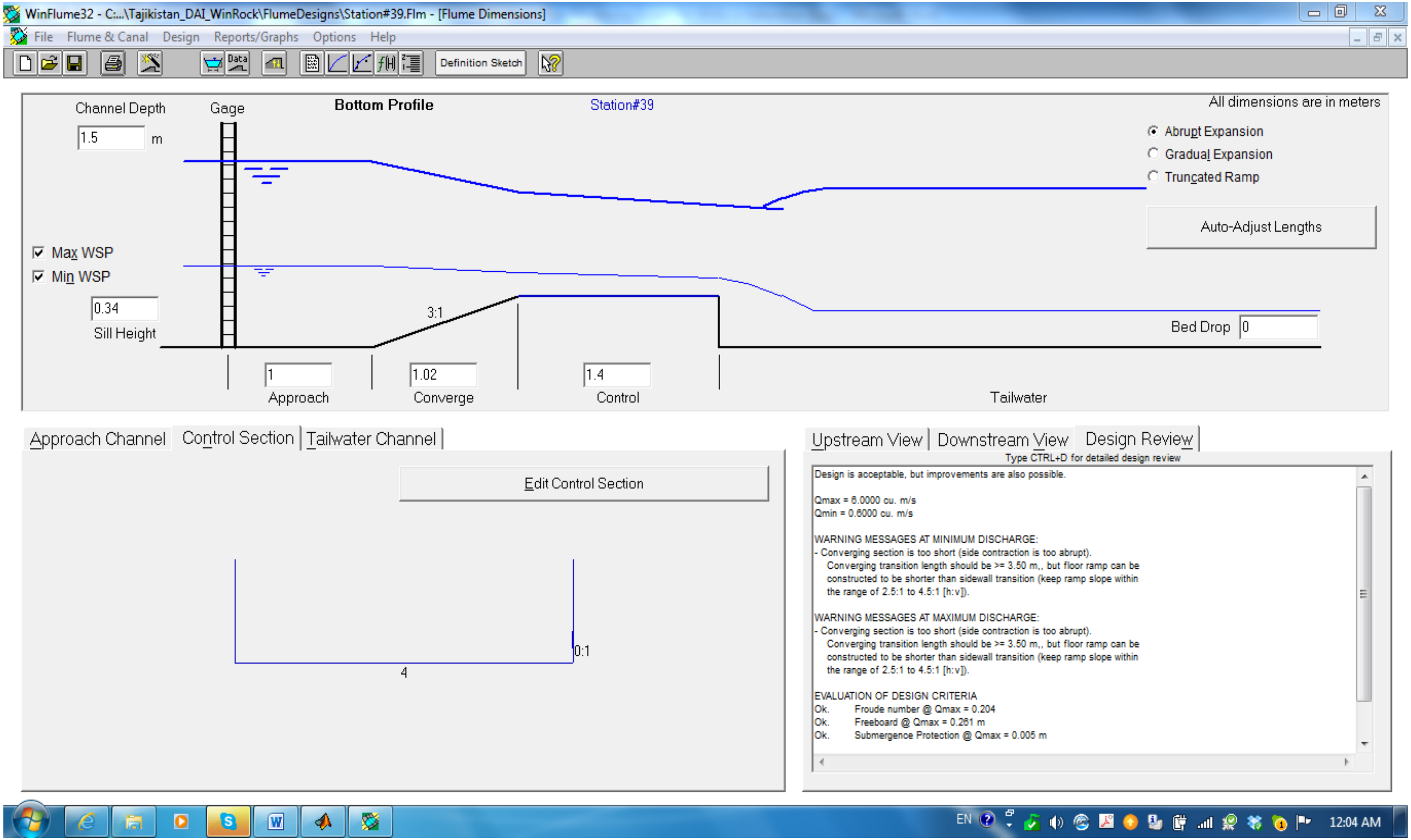

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#33.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#33
All dimensions are in meters
3.5
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
1.27
Sill Height
3:1
Bed Drop
0
2
Approach
3.81
Converge
1.75
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1:1
3.6
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 15.000 cu. m/s
Qmin = 1.000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.256
Ok. Freeboard @ Qmax = 1.108 m
Ok. Submergence Protection @ Qmax = 0.002 m
Ok. Submergence Protection @ Qmin = 0.939 m
Ok. Expected uncertainty @ Qmax = ±2.03 %
Ok. Expected uncertainty @ Qmin = ±4.05 %
EN
8:56 PM

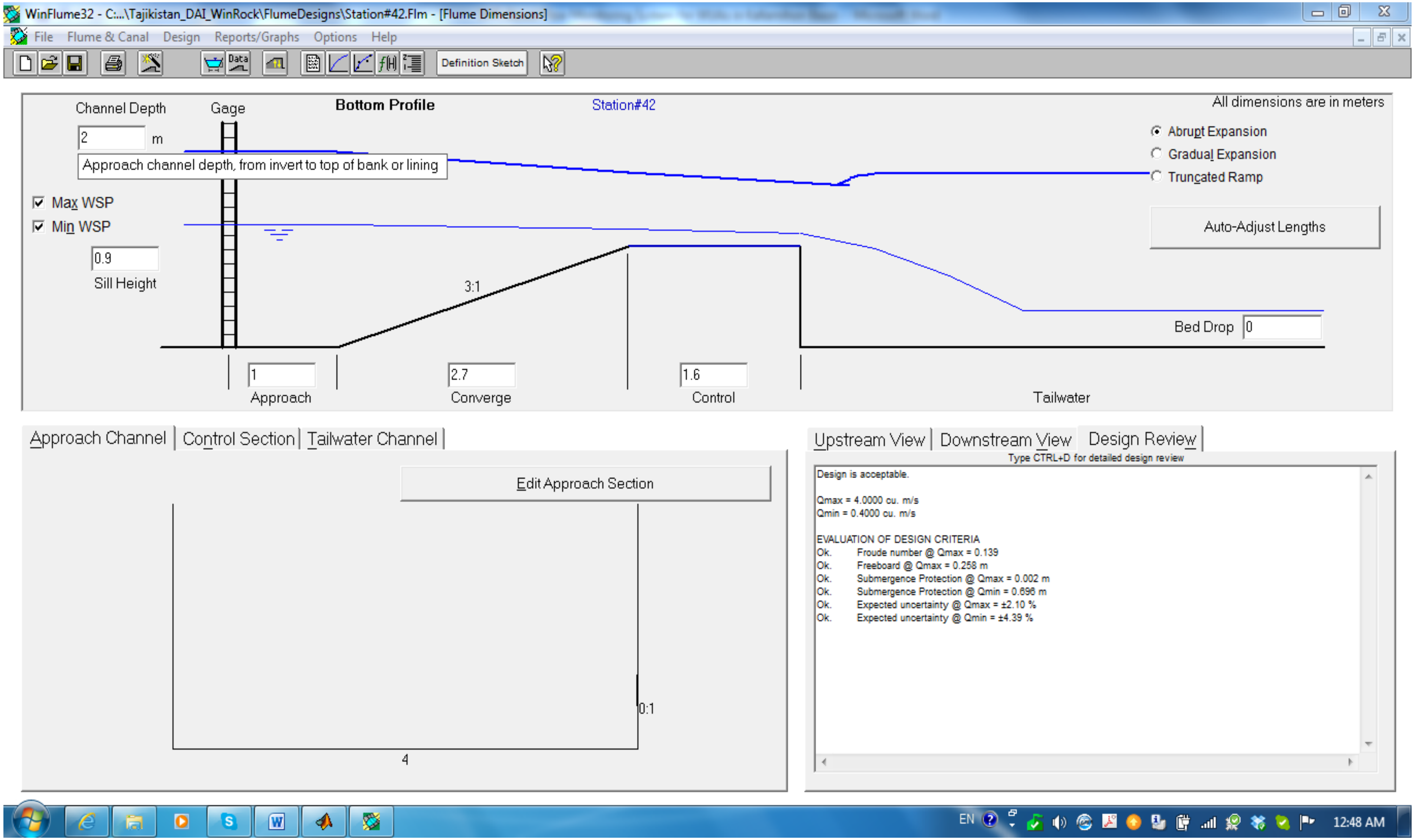

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#34.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#34
All dimensions are in meters
2
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.73
Sill Height
3:1
Bed Drop
0
2
Approach
2.19
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.5:1
2
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 8.0000 cu. m/s
Qmin = 0.8000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.353
Ok. Freeboard @ Qmax = 0.391 m
Ok. Submergence Protection @ Qmax = 0.001 m
Ok. Submergence Protection @ Qmin = 0.445 m
Ok. Expected uncertainty @ Qmax = ±2.13 %
Ok. Expected uncertainty @ Qmin = ±3.90 %
EN
8:57 PM

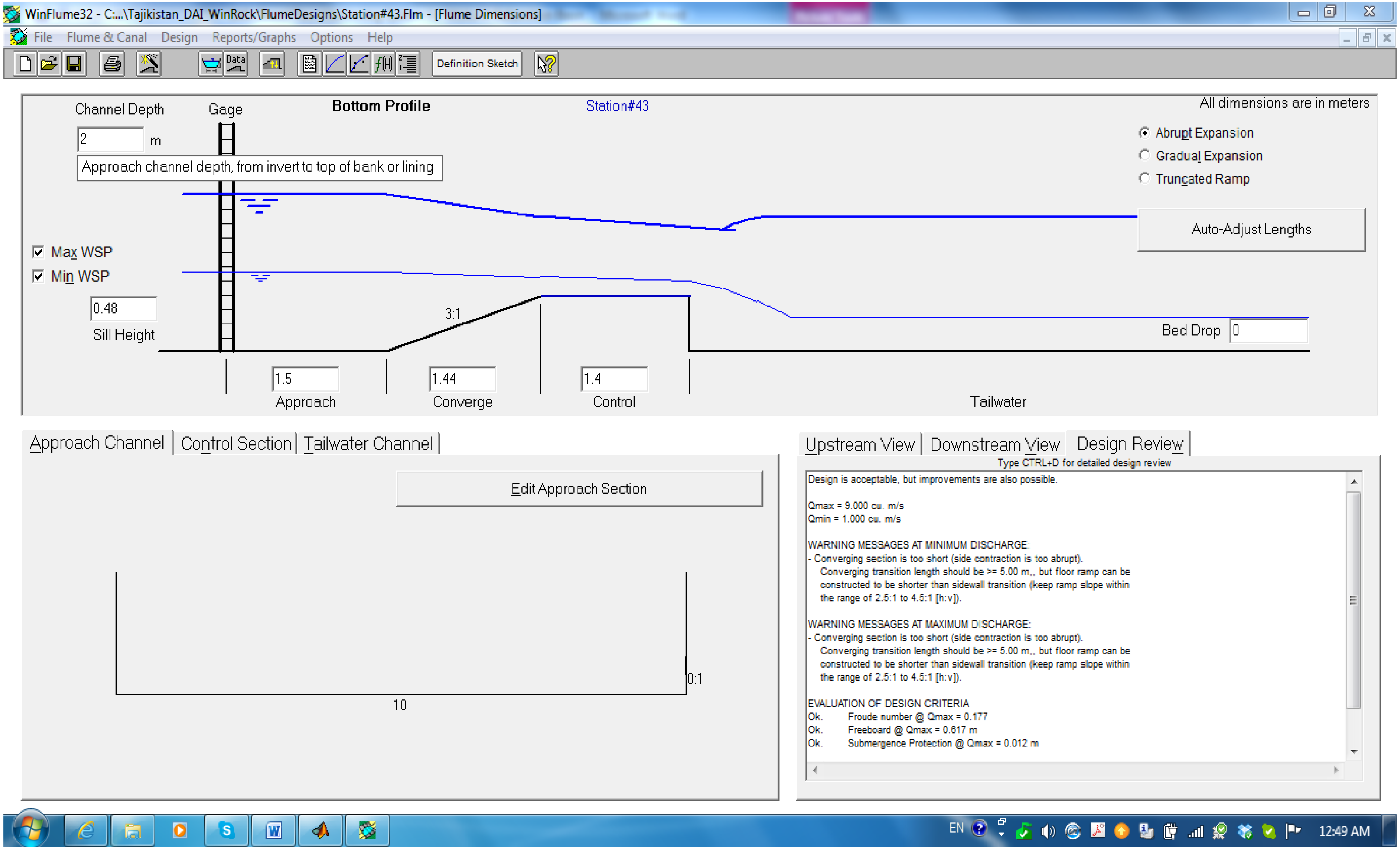

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#35.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#35
All dimensions are in meters
2 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.8
Sill Height
3:1
Bed Drop 0
1
Approach
2.4
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
2
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 2.5000 cu. m/s
Qmin = 0.3000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.169
Ok. Freeboard @ Qmax = 0.227 m
Ok. Submergence Protection @ Qmax = 0.005 m
Ok. Submergence Protection @ Qmin = 0.630 m
Ok. Expected uncertainty @ Qmax = ±2.05 %
Ok. Expected uncertainty @ Qmin = ±3.59 %
8:58 PM

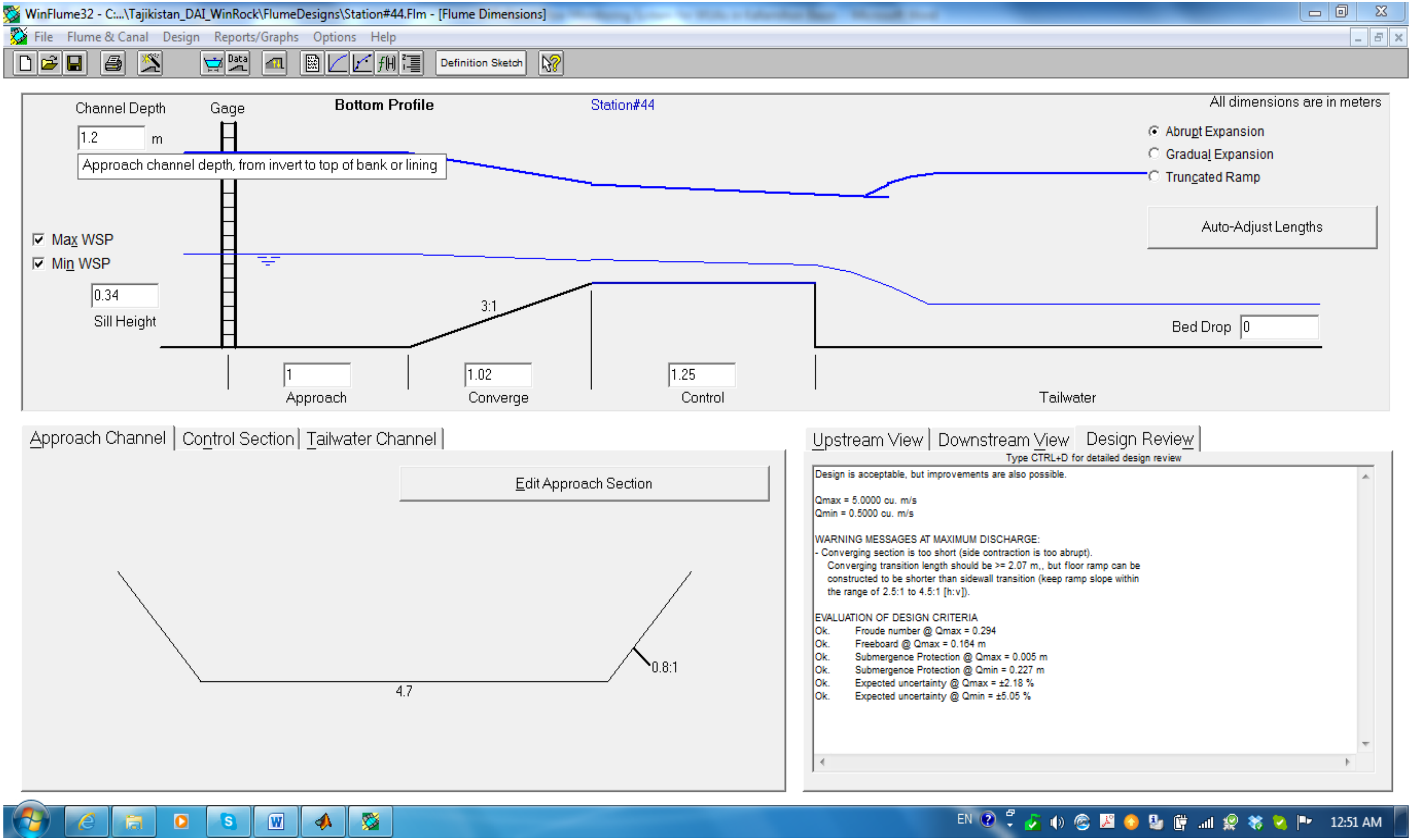

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#37.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#37
All dimensions are in meters
1.6 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.51
Sill Height
3:1
Bed Drop 0
1
Approach
1.53
Converge
1.25
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
2.5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 2.0000 cu. m/s
Qmin = 0.2000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.163
Ok. Freeboard @ Qmax = 0.249 m
Ok. Submergence Protection @ Qmax = 0.002 m
Ok. Submergence Protection @ Qmin = 0.396 m
Ok. Expected uncertainty @ Qmax = ±2.10 %
Ok. Expected uncertainty @ Qmin = ±4.42 %
EN
8:59 PM

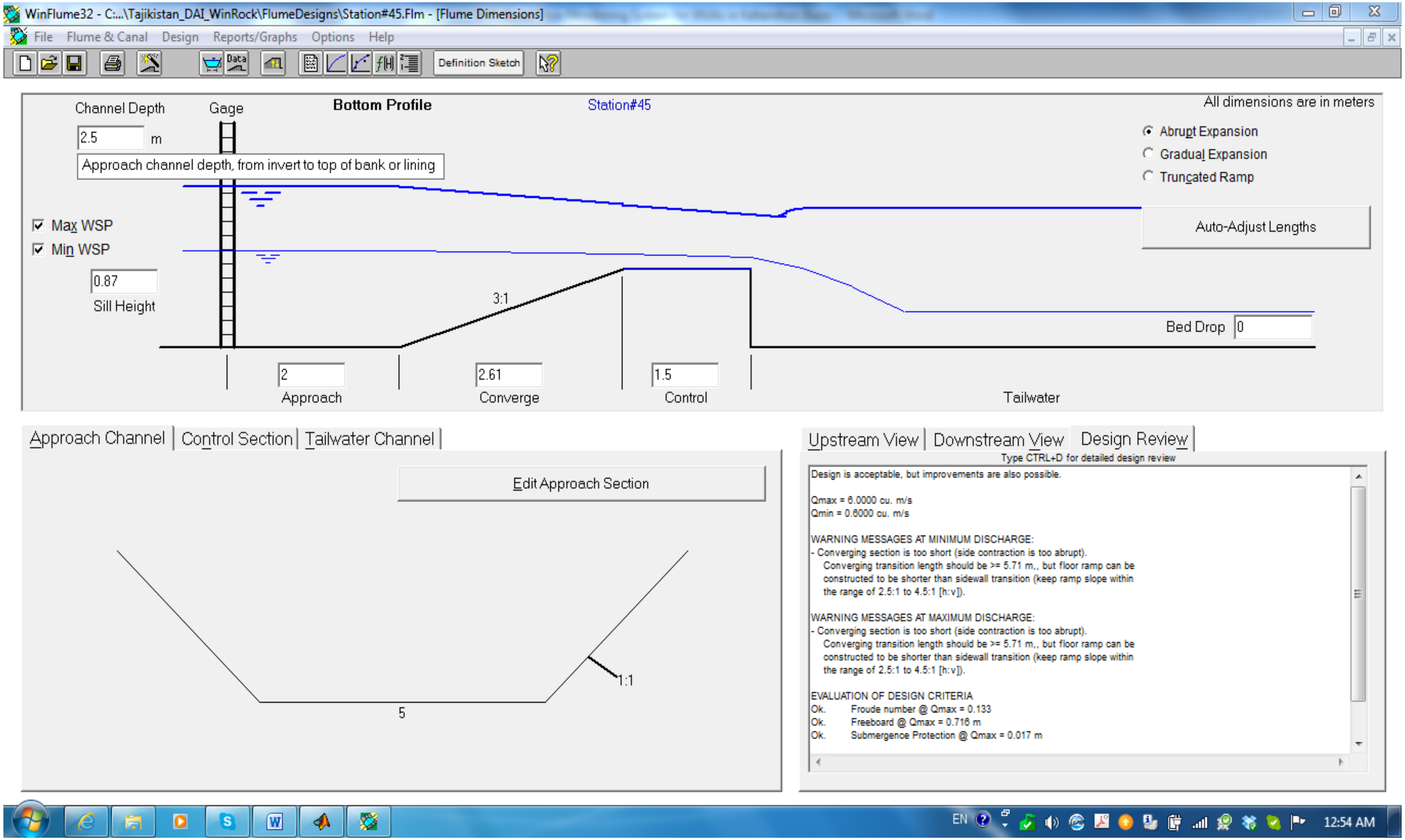

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#38.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#38
All dimensions are in meters
2
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.4
Sill Height
3:1
Bed Drop
0
1
Approach
1.2
Converge
1.4
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.5:1
7.2
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 8.0000 cu. m/s
Qmin = 0.8000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 4.42 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 4.42 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.219
Ok. Freeboard @ Qmax = 0.665 m
Ok. Submergence Protection @ Qmax = 0.018 m
EN
9:01 PM

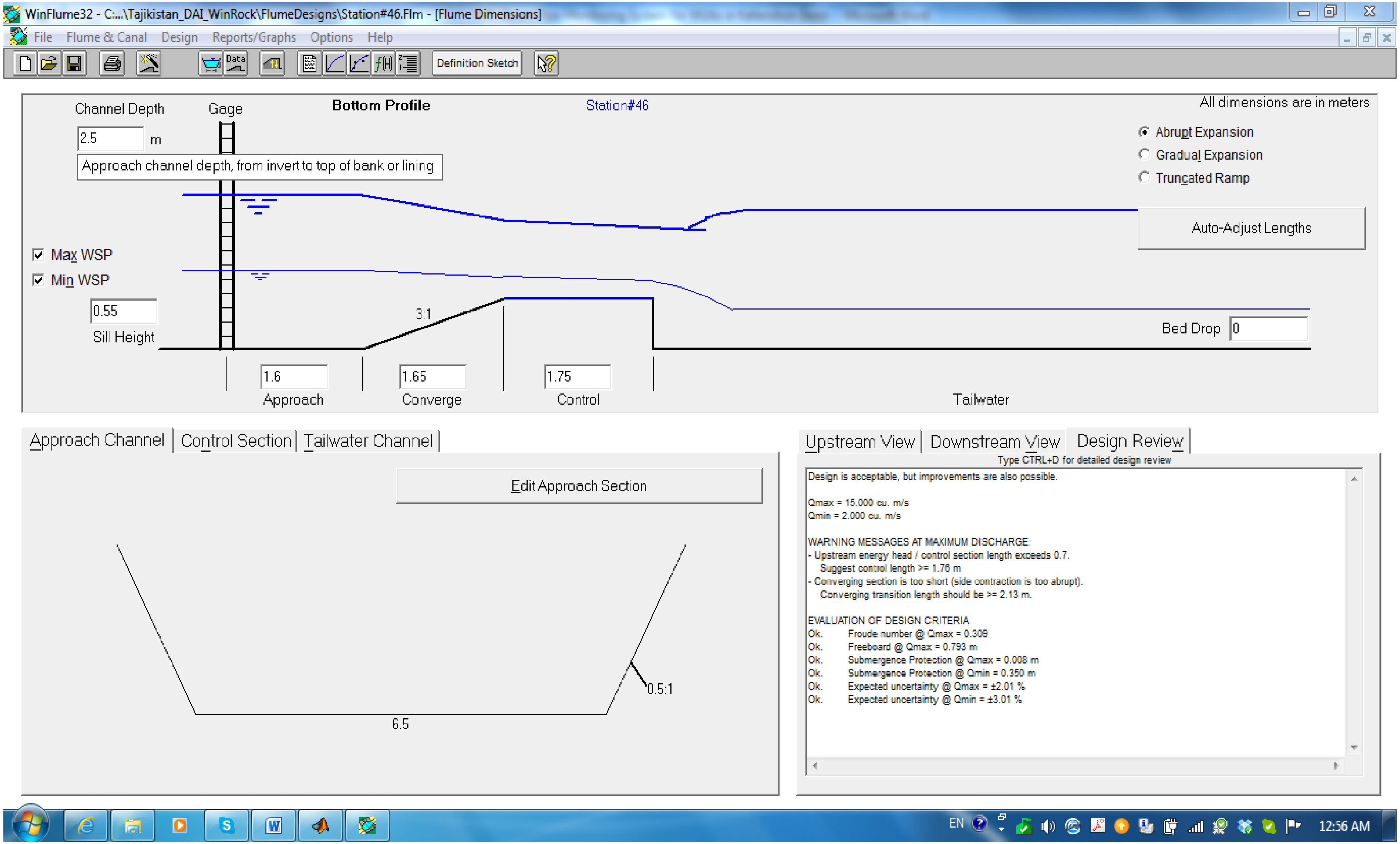

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#39.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
1.5 m
Gage
Bottom Profile
Station#39
All dimensions are in meters
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.34
Sill Height
3:1
Bed Drop 0
1 Approach
1.02 Converge
1.4 Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Control Section
0:1
4
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 6.0000 cu. m/s
Qmin = 0.6000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.50 m., but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.50 m., but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.204
Ok. Freeboard @ Qmax = 0.261 m
Ok. Submergence Protection @ Qmax = 0.005 m
EN
12:04 AM

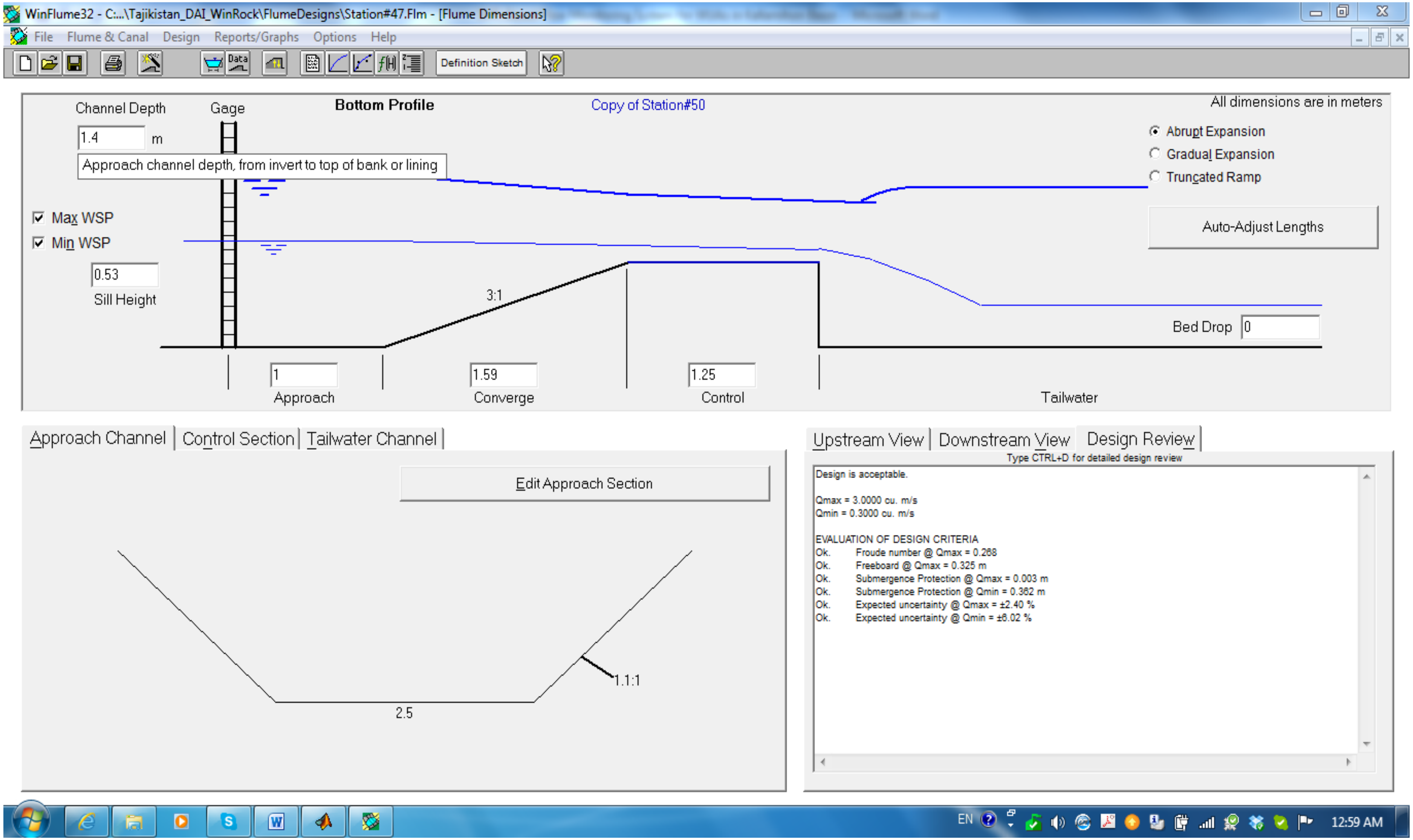

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#42.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#42
All dimensions are in meters
2 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.9
Sill Height
3:1
Bed Drop 0
1
Approach
2.7
Converge
1.6
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0:1
4
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 4.0000 cu. m/s
Qmin = 0.4000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.139
Ok. Freeboard @ Qmax = 0.258 m
Ok. Submergence Protection @ Qmax = 0.002 m
Ok. Submergence Protection @ Qmin = 0.696 m
Ok. Expected uncertainty @ Qmax = ±2.10 %
Ok. Expected uncertainty @ Qmin = ±4.39 %
EN
12:48 AM

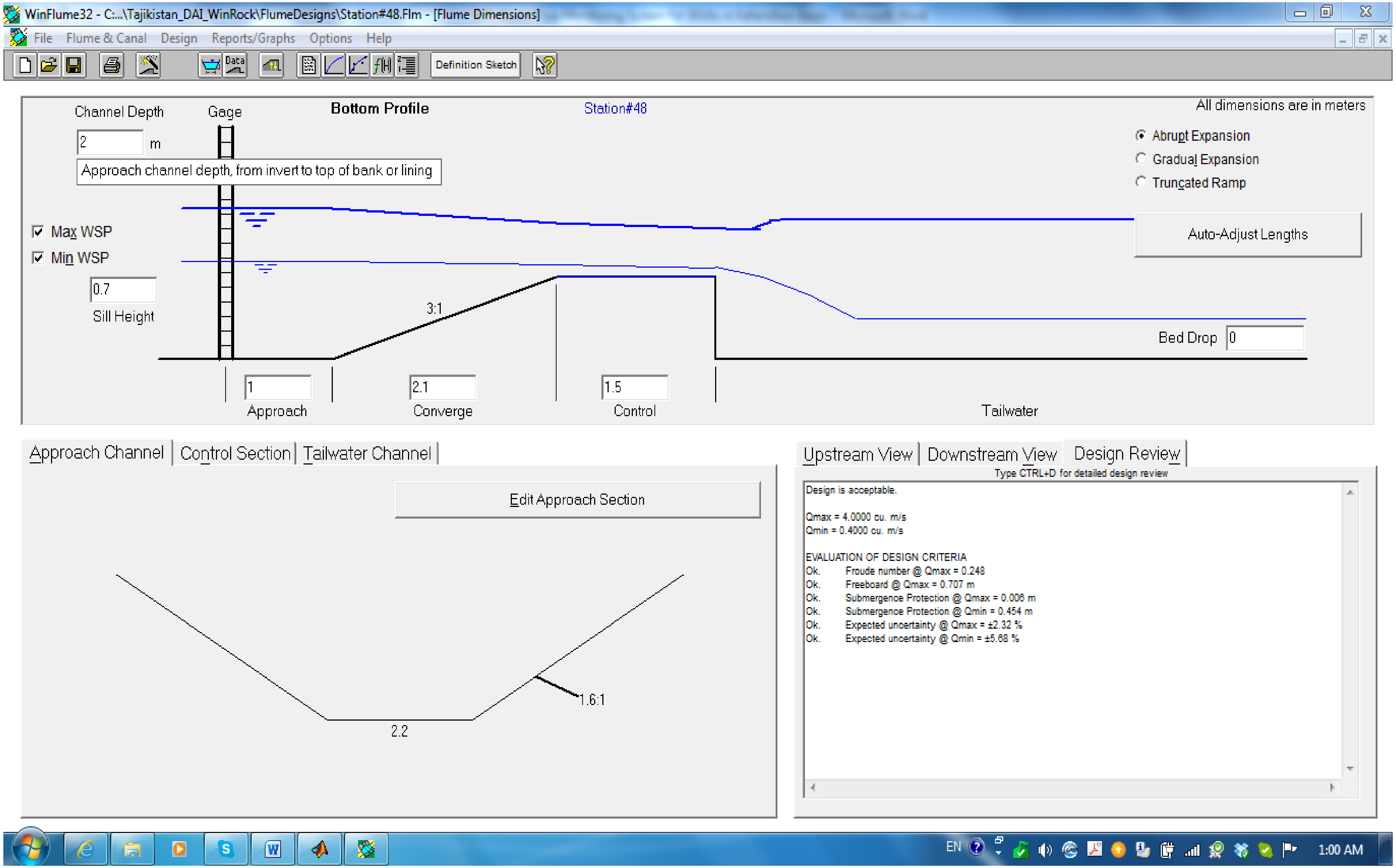

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#43.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#43
All dimensions are in meters
2
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.48
Sill Height
3:1
Bed Drop
0
1.5
Approach
1.44
Converge
1.4
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
10
0:1
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 9.000 cu. m/s
Qmin = 1.000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 5.00 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 5.00 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.177
Ok. Freeboard @ Qmax = 0.617 m
Ok. Submergence Protection @ Qmax = 0.012 m
EN
12:49 AM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#44.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#44
All dimensions are in meters
1.2 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.34
Sill Height
3:1
Bed Drop 0
1 Approach
1.02 Converge
1.25 Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.8:1
4.7
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 5.0000 cu. m/s
Qmin = 0.5000 cu. m/s
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.07 m., but floor ramp can be constructed to be shorter than sidewall transition (keep ramp slope within the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.294
Ok. Freeboard @ Qmax = 0.164 m
Ok. Submergence Protection @ Qmax = 0.005 m
Ok. Submergence Protection @ Qmin = 0.227 m
Ok. Expected uncertainty @ Qmax = ±2.18 %
Ok. Expected uncertainty @ Qmin = ±5.05 %
EN
12:51 AM

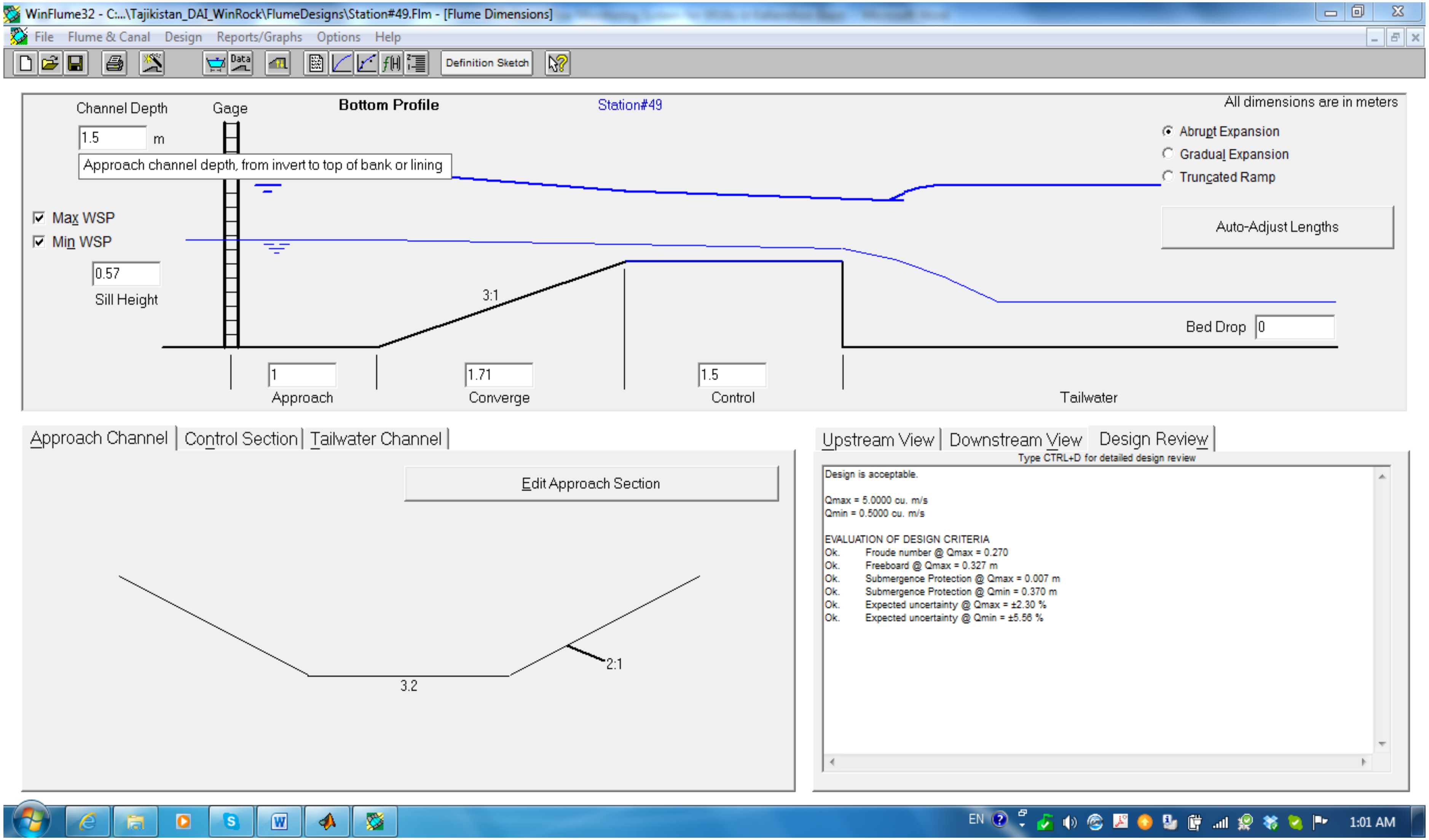

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#45.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
2.5 m
Approach channel depth, from invert to top of bank or lining
Gage
Bottom Profile
Station#45
All dimensions are in meters
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.87
Sill Height
3:1
Bed Drop 0
2
Approach
2.61
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1:1
5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 6.0000 cu. m/s
Qmin = 0.6000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 5.71 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 5.71 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.133
Ok. Freeboard @ Qmax = 0.716 m
Ok. Submergence Protection @ Qmax = 0.017 m
EN
12:54 AM

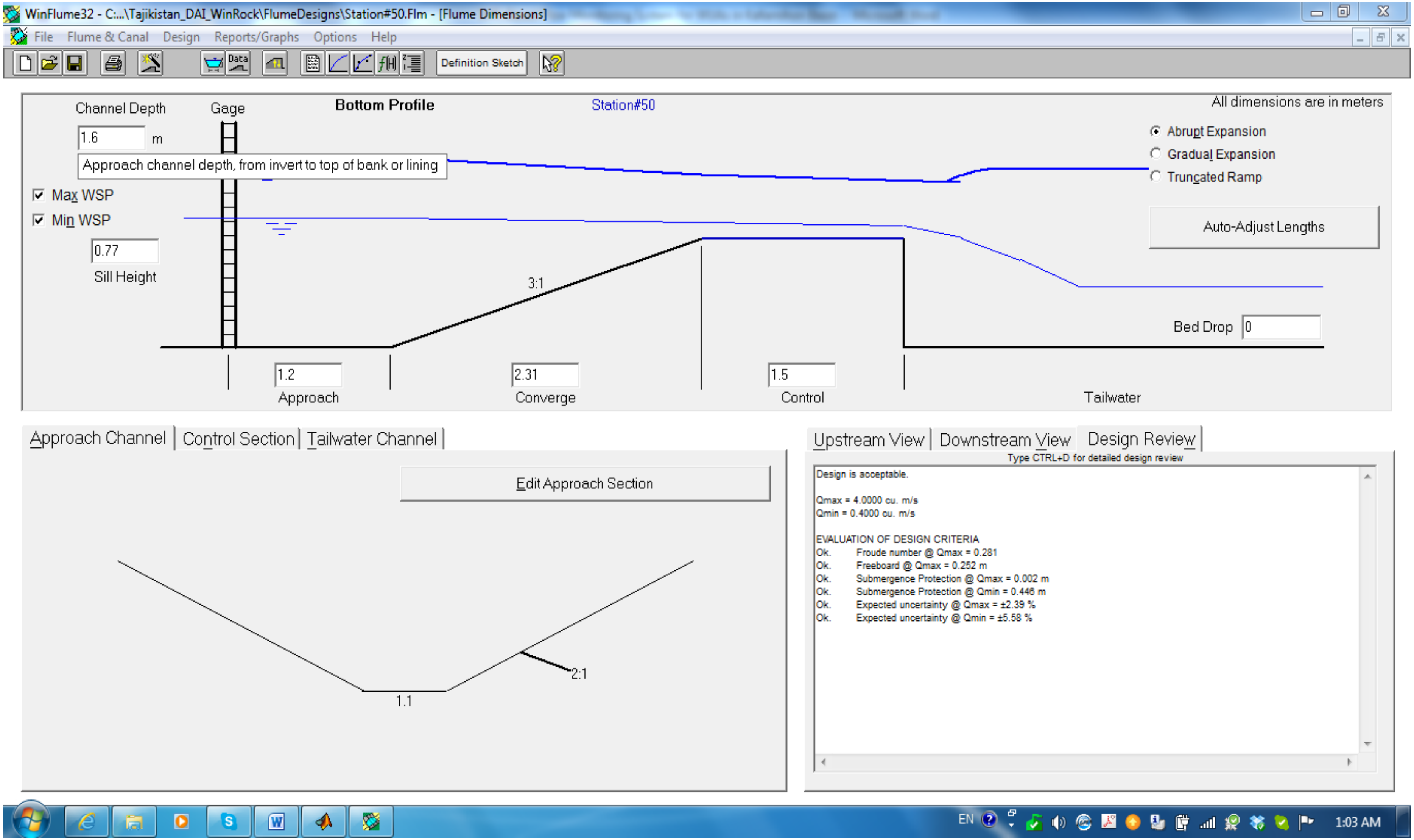

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#46.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#46
All dimensions are in meters
2.5
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.55
Sill Height
3:1
Bed Drop
0
1.6
Approach
1.65
Converge
1.75
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.5:1
6.5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 15.000 cu. m/s
Qmin = 2.000 cu. m/s
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Upstream energy head / control section length exceeds 0.7.
Suggest control length >= 1.76 m
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.13 m.
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.309
Ok. Freeboard @ Qmax = 0.793 m
Ok. Submergence Protection @ Qmax = 0.008 m
Ok. Submergence Protection @ Qmin = 0.350 m
Ok. Expected uncertainty @ Qmax = ±2.01 %
Ok. Expected uncertainty @ Qmin = ±3.01 %
EN
12:56 AM

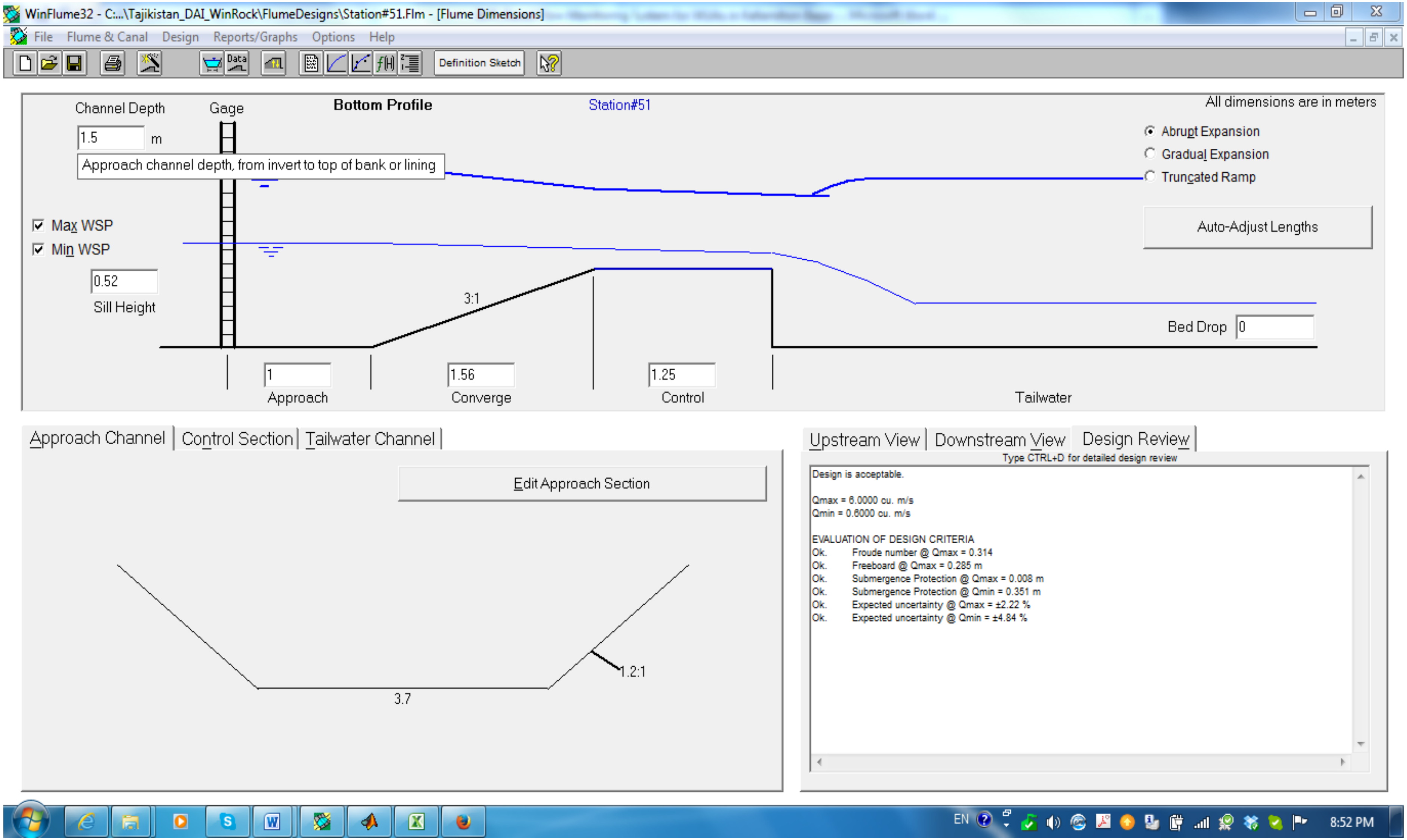

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#47.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
1.4
m
Gage
Bottom Profile
Copy of Station#50
All dimensions are in meters
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.53
Sill Height
3:1
Bed Drop
0
1
Approach
1.59
Converge
1.25
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.1:1
2.5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 3.0000 cu. m/s
Qmin = 0.3000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.268
Ok. Freeboard @ Qmax = 0.325 m
Ok. Submergence Protection @ Qmax = 0.003 m
Ok. Submergence Protection @ Qmin = 0.362 m
Ok. Expected uncertainty @ Qmax = ±2.40 %
Ok. Expected uncertainty @ Qmin = ±6.02 %
EN
12:59 AM

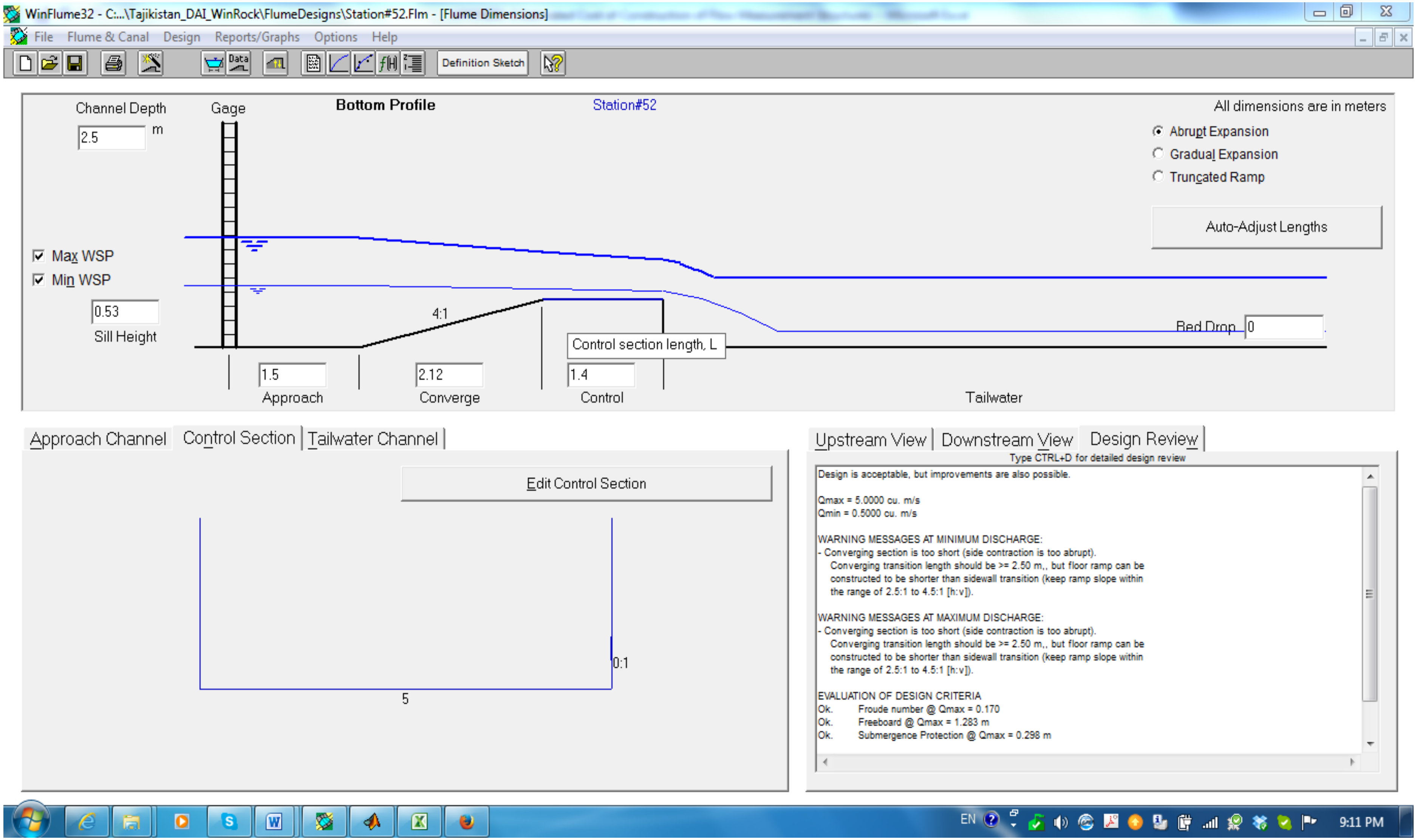


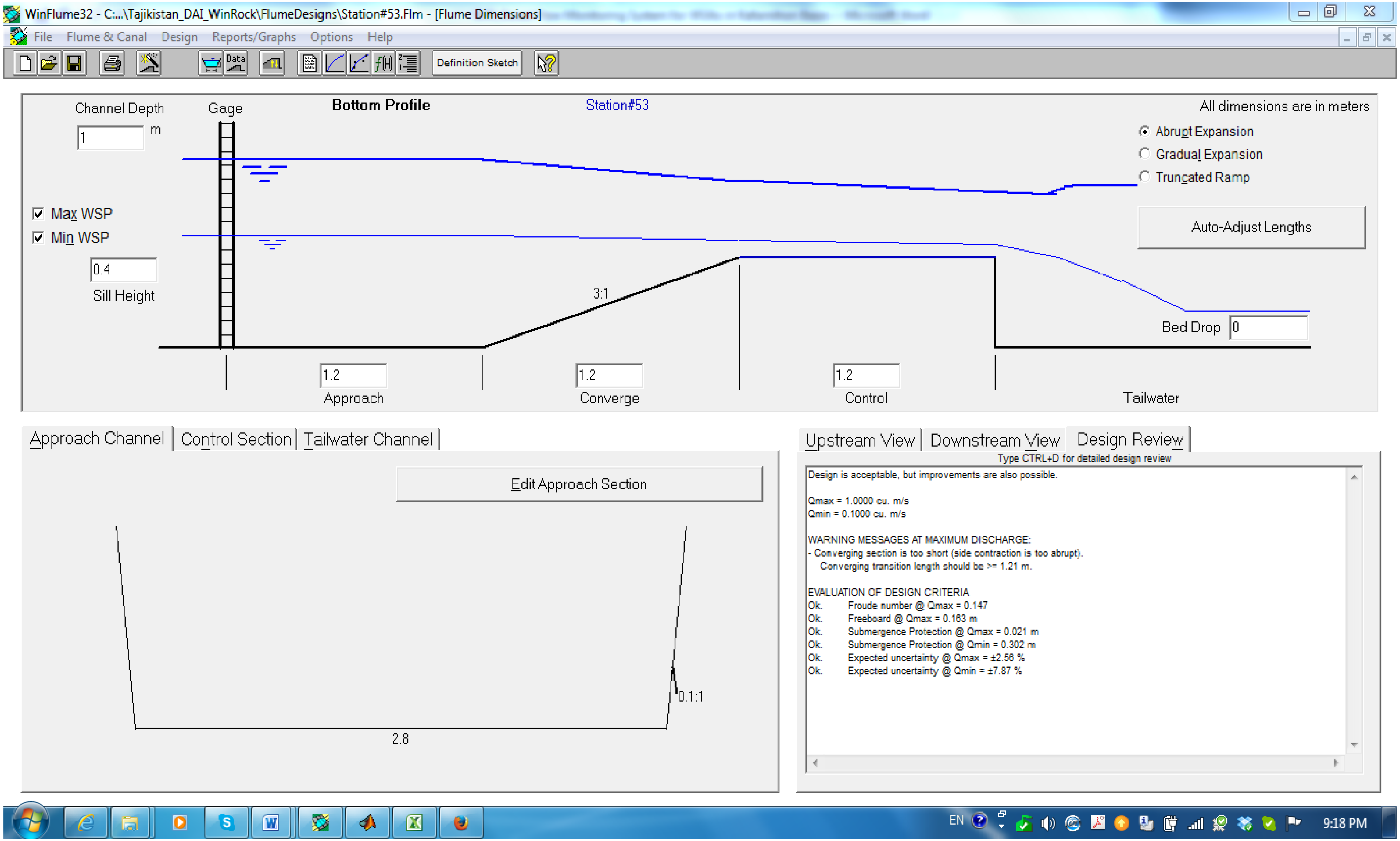
WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#48.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#48
All dimensions are in meters
2 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.7
Sill Height
3:1
Bed Drop 0
1
Approach
2.1
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.6:1
2.2
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 4.0000 cu. m/s
Qmin = 0.4000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.248
Ok. Freeboard @ Qmax = 0.707 m
Ok. Submergence Protection @ Qmax = 0.006 m
Ok. Submergence Protection @ Qmin = 0.454 m
Ok. Expected uncertainty @ Qmax = ±2.32 %
Ok. Expected uncertainty @ Qmin = ±5.68 %
EN
1:00 AM

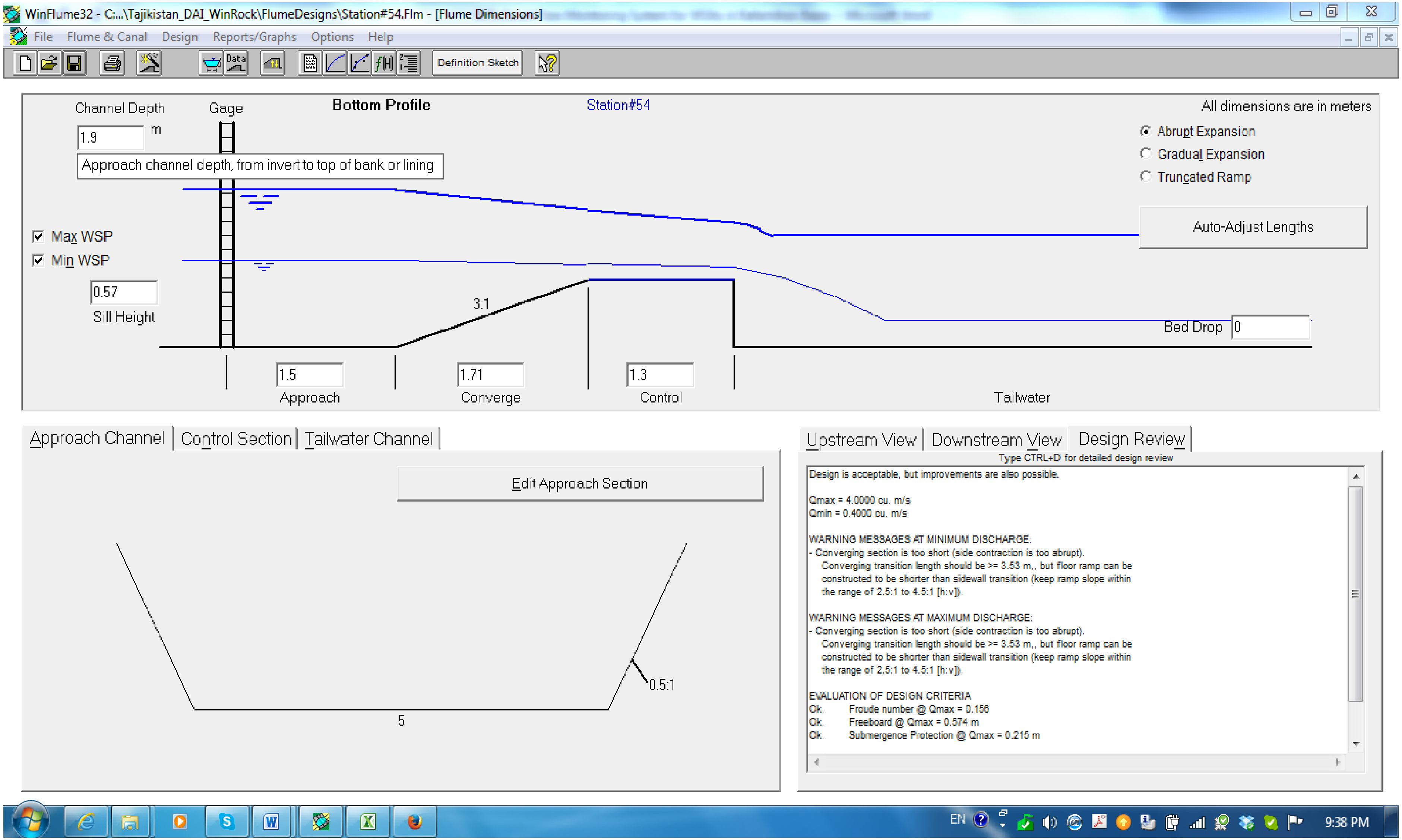

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#49.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#49
All dimensions are in meters
1.5
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Max WSP
Min WSP
Auto-Adjust Lengths
0.57
Sill Height
3:1
Bed Drop
0
1
Approach
1.71
Converge
1.5
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
3.2
2:1
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 5.0000 cu. m/s
Qmin = 0.5000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.270
Ok. Freeboard @ Qmax = 0.327 m
Ok. Submergence Protection @ Qmax = 0.007 m
Ok. Submergence Protection @ Qmin = 0.370 m
Ok. Expected uncertainty @ Qmax = ±2.30 %
Ok. Expected uncertainty @ Qmin = ±5.56 %
EN
1:01 AM

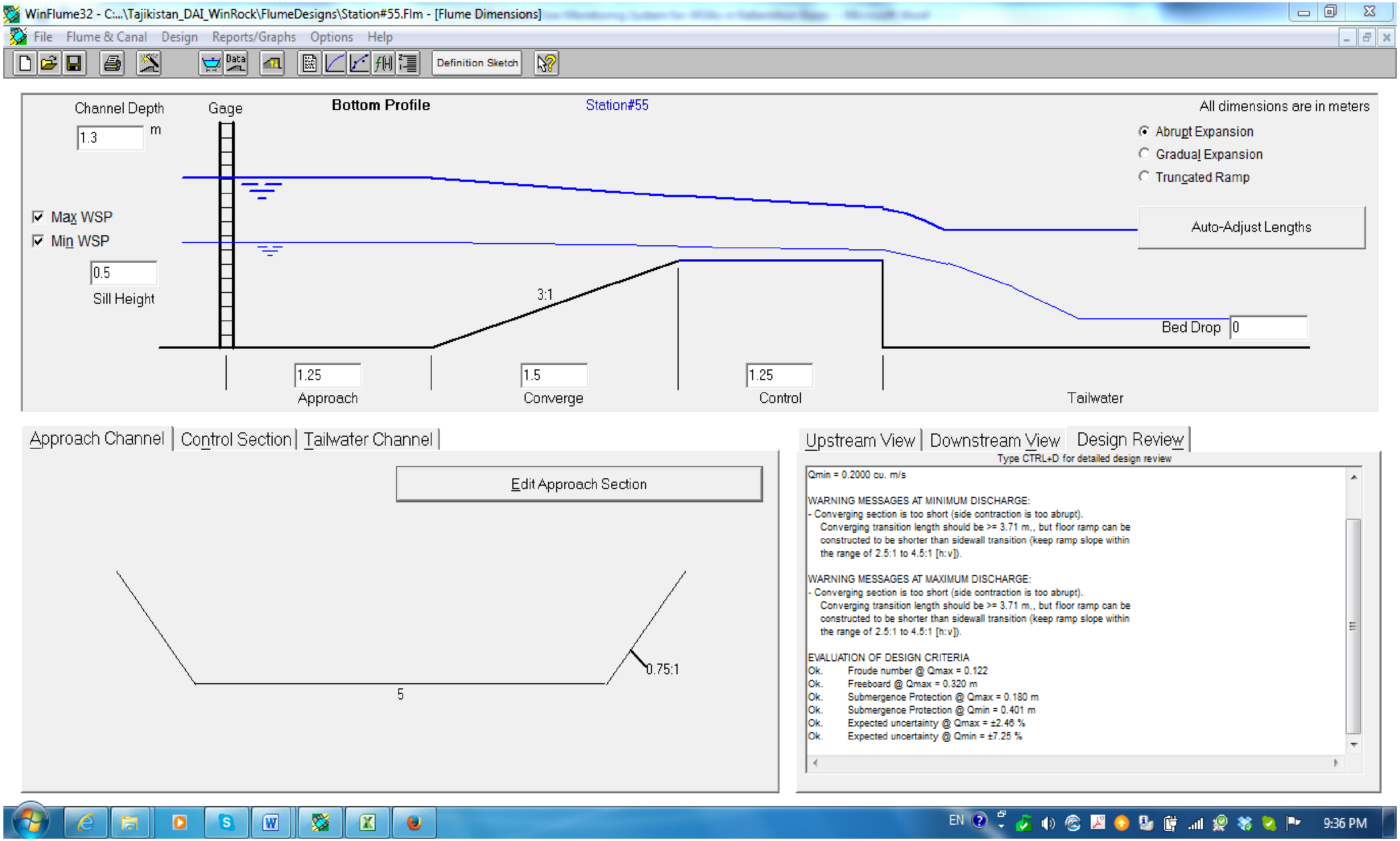

WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#50.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#50
All dimensions are in meters
1.6 m
Approach channel depth, from invert to top of bank or lining
Max WSP
Min WSP
0.77
Sill Height
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
3:1
Bed Drop 0
1.2 Approach
2.31 Converge
1.5 Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
2:1
1.1
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 4.0000 cu. m/s
Qmin = 0.4000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.281
Ok. Freeboard @ Qmax = 0.252 m
Ok. Submergence Protection @ Qmax = 0.002 m
Ok. Submergence Protection @ Qmin = 0.446 m
Ok. Expected uncertainty @ Qmax = ±2.39 %
Ok. Expected uncertainty @ Qmin = ±5.58 %
EN
1:03 AM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#51.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#51
All dimensions are in meters
1.5 m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.52
Sill Height
3:1
Bed Drop 0
1
Approach
1.56
Converge
1.25
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
1.2:1
3.7
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable.
Qmax = 6.0000 cu. m/s
Qmin = 0.6000 cu. m/s
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.314
Ok. Freeboard @ Qmax = 0.285 m
Ok. Submergence Protection @ Qmax = 0.008 m
Ok. Submergence Protection @ Qmin = 0.351 m
Ok. Expected uncertainty @ Qmax = ±2.22 %
Ok. Expected uncertainty @ Qmin = ±4.84 %
EN
8:52 PM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#52.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
2.5 m
Gage
Bottom Profile
Station#52
All dimensions are in meters
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.53
Sill Height
4:1
Control section length, L
Bed Drop 0
1.5
Approach
2.12
Converge
1.4
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Control Section
0:1
5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 5.0000 cu. m/s
Qmin = 0.5000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 2.50 m,, but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.170
Ok. Freeboard @ Qmax = 1.283 m
Ok. Submergence Protection @ Qmax = 0.298 m
EN
9:11 PM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#53.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
1 m
Gage
Bottom Profile
Station#53
All dimensions are in meters
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.4
Sill Height
3:1
Bed Drop 0
1.2
Approach
1.2
Converge
1.2
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.1:1
2.8
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 1.0000 cu. m/s
Qmin = 0.1000 cu. m/s
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 1.21 m.
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.147
Ok. Freeboard @ Qmax = 0.163 m
Ok. Submergence Protection @ Qmax = 0.021 m
Ok. Submergence Protection @ Qmin = 0.302 m
Ok. Expected uncertainty @ Qmax = ±2.56 %
Ok. Expected uncertainty @ Qmin = ±7.87 %
EN
9:18 PM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#54.Flm - [Flume Dimensions]
File Flume & Canal Design Reports/Graphs Options Help
Definition Sketch
Channel Depth
Gage
Bottom Profile
Station#54
All dimensions are in meters
1.9
m
Approach channel depth, from invert to top of bank or lining
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.57
Sill Height
3:1
Bed Drop
0
1.5
Approach
1.71
Converge
1.3
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.5:1
5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Design is acceptable, but improvements are also possible.
Qmax = 4.0000 cu. m/s
Qmin = 0.4000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.53 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.53 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.156
Ok. Freeboard @ Qmax = 0.574 m
Ok. Submergence Protection @ Qmax = 0.215 m
EN
9:38 PM


WinFlume32 - C:...\Tajikistan_DAI_WinRock\FlumeDesigns\Station#55.Flm - [Flume Dimensions]
File
Flume & Canal
Design
Reports/Graphs
Options
Help
Definition Sketch
Channel Depth
1.3
m
Gage
Bottom Profile
Station#55
All dimensions are in meters
Abrupt Expansion
Gradual Expansion
Truncated Ramp
Auto-Adjust Lengths
Max WSP
Min WSP
0.5
Sill Height
3:1
Bed Drop
0
1.25
Approach
1.5
Converge
1.25
Control
Tailwater
Approach Channel
Control Section
Tailwater Channel
Edit Approach Section
0.75:1
5
Upstream View
Downstream View
Design Review
Type CTRL+D for detailed design review
Qmin = 0.2000 cu. m/s
WARNING MESSAGES AT MINIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.71 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
WARNING MESSAGES AT MAXIMUM DISCHARGE:
- Converging section is too short (side contraction is too abrupt).
Converging transition length should be >= 3.71 m., but floor ramp can be
constructed to be shorter than sidewall transition (keep ramp slope within
the range of 2.5:1 to 4.5:1 [h:v]).
EVALUATION OF DESIGN CRITERIA
Ok. Froude number @ Qmax = 0.122
Ok. Freeboard @ Qmax = 0.320 m
Ok. Submergence Protection @ Qmax = 0.180 m
Ok. Submergence Protection @ Qmin = 0.401 m
Ok. Expected uncertainty @ Qmax = ±2.46 %
Ok. Expected uncertainty @ Qmin = ±7.25 %
EN
9:36 PM

APPENDIX 2 ESTIMATED COST OF CONSTRUCTION OF FLOW MEASUREMENT STRUCTURES

Station #	Type of Structure	Cost of Construction, $	Cost of Smart Cell Phone, $	Weir height, m	Weir width, m	Weir length , m	Channe l width, m	Channe l depth, m	Freeboard, m	Side slope	Estimated Volume of Concrete, m^3
1	**Trapezoidal BCW**	6768	150	1.00	12.80	1.70	10.00	2.80		1.40	30.08
2	Trapezoidal BCW	411	150	0.30	4.60	1.75	4.00	2.00		1.00	1.83
3a	Rectangular BCW	9904	150	0.75	4.00	3.00	10.30	3.50	0.75	0.00	44.02
3b	Rectangular BCW	12567	0	1.00	5.10	2.52	12.60	3.00	0.28	0.00	55.85
4	Trapezoidal BCW	1544	150	0.55	7.92	1.50	6.60	4.20		1.20	6.86
5	Trapezoidal BCW	2638	0	0.70	8.70	1.75	6.60	2.60		1.50	11.72
6	Rectangular BCW	10706	150	0.60	5.00	2.50	15.00	2.50	0.28	0.00	47.58
7	Rectangular BCW	6311	150	0.53	2.60	2.20	9.60	2.20	0.20	0.00	28.05
8	Rectangular BCW	4268	150	0.60	3.00	1.50	7.50	1.50	0.11	0.00	18.97
9	**Hydropost**	6000	150								0.00
10	No Need	0	0								0.00
11	Rectangular BCW	4537	150	0.40	8.00	1.50	8.00	1.50	0.17	0.00	20.17
12	No need	0	0								0.00

Station #	Type of Structure	Cost of Construction, $	Cost of Smart Cell Phone, $	Weir height, m	Weir width, m	Weir length, m	Channel width, m	Channel depth, m	Freeboard, m	Side slope	Estimated Volume of Concrete, m^3
13	In the Future	0	0								0.00
14	In the Future	0	0								0.00
15	Rectangular BCW	10259	150	0.70	10.00	1.75	14.00	2.50	0.71	0.00	45.59
16	Rectangular BCW	1822	150	0.70	0.90	1.50	2.00	1.80	0.11	0.00	8.10
17	Trapezoidal BCW	3582	150	0.81	9.75	1.60	7.00	1.70		1.70	15.92
18	Rectangular BCW	3694	150	0.65	4.00	1.50	5.00	1.70	0.25	0.00	16.42
19	Rectangular BCW	3690	150	0.52	4.50	1.40	6.00	1.65	0.22	0.00	16.40
20	In the Future	0	0								0.00
21	Rectangular BCW	2474	150	0.52	2.60	2.00	3.00	1.30	0.20	0.00	11.00
22	Rectangular BCW	2032	150	0.52	3.00	1.00	3.50	1.20	0.16		9.03
23	In the Future	0	0								0.00
24	In the Future	0	0								0.00
25	Rectangular BCW	4423	150	0.58	5.00	1.40	7.00	1.70	0.19	0.00	19.66
26	In the Future	0	0								0.00
27	Rectangular BCW	3485	150	0.50	4.00	1.35	6.00	1.60	0.22	0.00	15.49
28	Rectangular BCW	3278	150	0.37	4.00	1.50	6.00	1.50	0.14	0.00	14.57
29	Trapezoidal	1247	150	0.70	4.40	1.50	1.60	1.30		2.00	5.54

Station #	Type of Structure	Cost of Construction, $	Cost of Smart Cell Phone, $	Weir height, m	Weir width, m	Weir length , m	Channe l width, m	Channe l depth, m	Freeboard, m	Side slope	Estimated Volume of Concrete, m^3
	BCW										
30	In the Future	0	0								0.00
31	Rectangular BCW	2679	150	0.30	3.60	1.30	5.60	1.35	0.20	0.00	11.91
32	**Hydropost**	3000	150								0.00
33	Trapezoidal BCW	4878	150	1.27	6.14	1.75	3.60	3.50		1.00	21.68
34	Trapezoidal BCW	1270	0	0.73	4.19	1.50	2.00	2.00		1.50	5.64
35	Rectangular BCW	2134	150	0.80	1.50	1.50	2.00	2.00	0.23	0.00	9.48
36	**Hydropost**	3000	150								0.00
37	Rectangular BCW	1716	0	0.51	1.50	1.25	2.50	1.60	0.25	0.00	7.63
38	Rectangular BCW	4614	150	0.40	5.00	1.40	9.30	2.00	0.67	0.00	20.51
39	Rectangular BCW	3351	150	0.34	4.00	1.40	6.80	1.50	0.26	0.00	14.89
40	**Hydropost**	3000	150								0.00
41	No need	0	0								0.00
42	Rectangular BCW	3913	150	0.90	3.00	1.60	4.00	2.00	0.26	0.00	17.39
43	Rectangular BCW	5317	150	0.48	6.00	1.40	10.00	2.00	0.62	0.00	23.63
44	Rectangular BCW	3080	150	0.34	4.70	1.25	6.60	1.20	0.16	0.00	13.69
45	Rectangular	7202	150	0.87	4.00	1.50	10.60	2.50	0.72	0.00	32.01

Station #	Type of Structure	Cost of Construction, $	Cost of Smart Cell Phone, $	Weir height, m	Weir width, m	Weir length, m	Channel width, m	Channel depth, m	Freeboard, m	Side slope	Estimated Volume of Concrete, m^3
	BCW										
46	Rectangular BCW	6259	150	0.55	6.50	1.75	9.50	2.50	0.80	0.00	27.82
47	Trapezoidal BCW	621	150	0.53	3.67	1.25	2.50	1.40		1.10	2.76
48	Trapezoidal BCW	1259	150	0.70	4.44	1.50	2.20	2.00		1.60	5.59
49	Trapezoidal BCW	1128	150	0.57	5.48	1.50	3.20	1.50		2.00	5.01
50	Trapezoidal BCW	1380	0	0.77	4.18	1.50	1.10	1.60		2.00	6.13
51	Trapezoidal BCW	813	150	0.52	4.95	1.25	3.70	1.50		1.20	3.62
52	Rectangular BCW	4064	150	0.53	5.00	1.40	7.00	2.50	1.28	0.00	18.06
53	Rectangular BCW	1598	150	0.40	2.00	1.20	3.00	1.00	0.16	0.00	7.10
54	Rectangular BCW	3877	150	0.57	3.50	1.30	7.00	1.90	0.57	0.00	17.23
55	Rectangular BCW	3370	150	0.50	3.50	1.25	7.00	1.30	0.32	0.00	14.98
	TOTAL COST	**$179,163**	**$6,150**								

APPENDIX – 3 EXCEL-SPREADSHEET FOR FLOW CALCULATIONS AT WUA LEVEL

WUA name	OBI HAYOT
WUA Irrigated Area, ha	800
Volume of water delivered, m3	0
Volume of water delivered per hectare, m3/ha	0

Date	Inflow Point			Outflow Point			
	Gage Reading, cm	flow rate, m3/s	Volume of Inflow, m3/day	Gage Reading, cm	flow rate, m3/s	Volume of outflow, m3/day	Volume of water received by WUA, m3
April 1, 2014							
April 2, 2014			0			0	0
April 3, 2014			0			0	0
April 4, 2014			0			0	0
April 5, 2014			0			0	0
November 20, 2014			0			0	0
November 21, 2014			0			0	0
November 22, 2014			0			0	0
November 23, 2014			0			0	0
November 24, 2014			0			0	0
November 25, 2014			0			0	0
November 26, 2014			0			0	0
November 27, 2014			0			0	0
November 28, 2014			0			0	0
November 29, 2014			0			0	0
November 30, 2014			0			0	0
			CUMULATIVE VOLUME RECEIVED				0

USAID FAMILY FARMING PROGRAM

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